AVIATION

The Oldest American Aeronautical Magazine

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A C.C.A. Fairchild Cabin Monoplane above the clouds en route to Montreal

VOLUME XXVI

NUMBER 3

Special Features

Aeronautical Engineering Supplement
Short Distance Racing and Handicapping
The Refueling Flight of the "Question Mark"

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Index to Contents

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Future Production

ONE of the fundamental problems which faces the board of directors and stockholders of every aircraft concern is the number of different types which they shall produce. Off hand, it would seem as if the best policy was to bring out several different types, and, if possible, a complete line. Not only does this give a wider field for manufacturing, and thereby increases the possibilities of large volume, but, more important still, it gives an opportunity of supplying distributors and dealers with the various types which their customers may demand.

During 1928 there was a decided tendency to increase the number of types turned out by aircraft constructors, or to achieve the same end by combinations of manufacturers producing different types. Especially during this formative period, when the popular type cannot be predicted with too great accuracy, it may be well to have several different types under way.

In making their decision, however, the directors should not overlook the importance of concentration. Few people can be equally good at a variety of things. Most of them, if they are to be successful, must concentrate on one particular specialty. Too much time and effort cannot be spent on the design and construction of a plane. A plane may be outwardly much the same from one year to another, but actually it may be either vastly improved or may be not so good. For example, the air mail operated De Havillands, designed in 1917, up until 1926. Through all this period minor changes of improvements were made as defects were shown up. As a result those old mail planes held their own for a long time against planes designed ten years later, and it was with difficulty that many pilots were persuaded to bestow their favor upon the newer designs.

Concentration by an organization on one particular type must of necessity achieve better results than if the efforts of the same organization are spread over many products. From the manufacturing point of view, there is nothing that raises the cost more than too much diversification and change. From the engineering point of view, there is no doubt but that a detailed study of one particular type will lead to perfection that cannot be achieved if the staff is constantly bringing out new models. New models educate the engineer, but do not necessarily mean the production of the best planes. Even from the sales point of view different methods and a different mentality are required to sell planes of different types. For example the selling of a few expensive transport planes requires a different mentality than the selling of quantities of two seater planes. Distributors and dealers can handle the products of different manufacturers provided that they do not compete and there seems to be no absolute necessity of their representing only one organization.

In the automobile field there has been a tendency in the past few years for companies to specialize in one particular branch of the field rather than to put out several radically different types and sizes. As production goes up in the airplane field it is perfectly possible that the present tendency towards several different types may be reversed. Large production of a single type in one plant is more economical than the same production of a variety of types. The company that establishes itself as the leader in a particular type such as the three seater open cockpit plane is in an enviable position and may be as successful as a company which produces several models but is not the leader in any of them.

Service Establishments

WITH aircraft sales completion becoming more keen each new dawn, and the item of service becoming a major factor in the sale of aircraft, there is now open a new field within a field which, if entered with a certain amount of business caution and a certain amount of knowledge pertaining to procedure of operation, should prove highly profitable to all parties concerned.

It stands to reason that the manufacturer can only act in an advisory, or perhaps a supervising capacity, in the matter of service. It is for him to see that his distributors and dealers perform the actual servicing duties. But, if such an arrangement is found to be impractical for financial reasons or lack of servicing knowledge, he must look elsewhere for the right parties and establish a service organization that is apart from his regular sales organization.

A combination sales and service organization is of course the ideal situation, but in view of the fact that at present many distributors and dealers must of necessity represent two or three non-competitive manufacturers, it follows that the servicing situation must be handled in a similar manner. Assuming that servicing must be handled outside of the sales organization because of the fact that more than one manufacturer must be represented in order to bring about a profit, it would seem altogether advisable for groups of well financed individuals (preferably those experienced in servicing work) to consider seriously active participation in this new field.

It is quite possible that state-wide representation of several non-competing manufacturers could be obtained. Then, a base of operation could be established at the largest airport in the territory. Such a base would handle local work and also act as a supply depot for the smaller shops scattered throughout the territory. The small shops could be independently owned for that matter and, act as representatives of the main service establishment. The initial capital required for such a venture is of course no small item, but the cooperation of the various manufacturers and the even closer cooperation of the various distributors and dealers in the territory, the amount of business obtainable should fully compensate for the original investment.

The Refueling Flight *of the* "Question Mark"

By Charles F. McReynolds

ALTHOUGH it has broken every record for sustaining human beings above the surface of the earth, either in balloons, dirigibles, or heavier-than-air craft, the Army's Atlantic C-2A monoplane "Question Mark" is in no sense of the word a "stunt" plane. It is a true flying laboratory, planned to test the durability of engines in continued operation while in the air, to test the plane, its equipment, and its crew for the affect of long continued flight, but most particularly planned to test the practicability of regular refueling of planes while in full flight and with present equipment. Following the record attempt, Maj. Carl Spatz, commanding ofcer of the endurance flight, stated that the chief thing they had accomplished was to refuel so many times and under so many varying conditions that no one could doubt the complete success of refueling methods which have been developed.

It is interesting to know that 37 contacts were made during the 150 hr. flight between the "Question Mark" and her nurse planes. The 37 contacts entailed a total of approximately four hours of contact flying. During this four hours of contact more than 5,000 gal. of gasoline, 250 gal. of oil, and approximately 2,000 lb. of food and supplies were transferred to the "Question Mark." This totals almost 42,000 lb. of weight handled or almost 21 tons of material that was placed on board the tri- engined Fokker while in flight. Numerous night contacts were made, some of them despite low visibility and bad air currents; and on one occasion a seven minute contact was made when all lights on the "Question Mark" were out due to low batteries, 180 gal. of gasoline being placed aboard. Nineteen full meals were transferred to the crew, while still warm, and more than two dozen quarts of ice cream were placed on board while still cold. Telegrams, letters, a collapsible bath tub, a supply of bath towels, woolen underwear, a rubber suit for Major Spatz, a window for the cabin, to replace one that had blown away, and many other items of miscellaneous nature were delivered to the crew. It is quite apparent that refuel and supply methods are now feasible enough to keep a plane up indefinitely if engines could be kept turning over.

Only Two Official Records Credited

The only official records to be credited to the plane are two new refueling records, one the new American record for having surpassed the 37 hr., 15 min. and 40 sec. flight of Lieuts. Lowell Smith and Paul Richter over San Diego, Calif., in an Army De Havilland during 1923, and the other a new world's record for endurance by means of refueling because of excelling the 60 hr. 7 min. flight of Adjutant Louis Crooy and Sergeant Victor Groenen, made in Belgium during 1928. The new American and world refueling endurance record now stands at 150 hr. 40 min. 14 sec., the start having been made at 7:26:46 A. M. Jan. 1, 1929, and the landing at 2:07:01 P. M. Jan. 7, 1929. Both start and finish were on the runways of the Los Angeles Metropolitan Airport, Van Nuys, Calif., under the supervision of N. A. A. officials headed by Dudley M. Steele, and with Joe Nikrent as timer.

Besides these two official records the "Question Mark" unofficially travelled approximately 10,000 mi. to break the former record of 4,417 mi. established by Capt. Arturo Ferrarin and Major Carlo del Prete when they flew a Savoia monoplane from Rome to Port Natal, Brazil, in

Action picture of the Army's Atlantic C-2A Fokker monoplane "Question Mark" in the air above Los Angeles

1928, and also to surpass the 6,000 mi. flight of the Graf Zeppelin during its recent voyage to America, although the official distance over L. A.-San Diego course was only 11 laps, or 2,828.1 mi.

In addition to breaking all distance records the "Question Mark" surpassed the following records for endurance, but since they are in a different class she cannot claim any of them: American Endurance without refueling, Brock and Schlee, 59 hr., 1928; World's heavier than air, Johann Risticz and Wilhelm Zimmerman, 65 hr. 25 min., Germany; Spherical balloon endurance, Kaulen of Germany, 87 hr.; Graf Zeppelin, 111½ hr. on 1928 flight to America; French dirigible "Dixmude," 118 hr. 41 min.

Those technically minded will at once inquire just what it was that finally caused the plane to descend. Undoubtedly the fact that valve mechanisms and spark plugs functioned for more than 150 hr. without inspection or adjustment is the answer. The rocker arms on the left engine finally gave way, apparently after failure of the rocker arm lubrication system, causing that engine to cut out entirely. The other two engines were opened full to try to keep the plane in the air while Sergt. Roy Hooe repaired the trouble. Although Sergeant Hooe was able to climb out to the engine, diagnose the trouble and start work on the valve mechanism, the remaining two engines did not prove equal to the added strain and the plane was forced to the ground before the trouble could be remedied.

Dudley Steele, manager of the Aviation Department of Richfield Oil Co., congratulating the personnel of the "Question Mark." Left to right: Major Spatz, commander of the plane, Captain Eaker, Lieutenant Halverson, Lieutenant Quesada, and Sergeant Hooe

In the opinion of Major Spatz, it will not be feasible to attempt the regular repair of engines in midair until they are placed completely inside an engine room where the mechanic can readily work on any part.

Although not wishing to make any definite prophecy for the future, Major Spatz pointed out that from a military standpoint the successful demonstration of refueling means that bombing plans can now take off with heavy loads of bombs and little gasoline, refuel over the lines with a greater load of fuel than they could have lifted from the ground and continue to a more distant objective than would otherwise have been possible. Also it is apparent that a large bomber returning against adverse winds and finding itself low on fuel could radio for a refuel plane, rendezvous in midair, and then continue safely to the home base instead of being forced down behind the enemy lines. At sea, important scouting planes could be kept aloft indefinitely by refueling, thus permitting the fleet commander an uninterrupted command of the scene of action.

An Asset to Non-Stop Distance Flying

An application of refueling which members of the "Question Mark" crew expect to see soon is its value for long distance non-stop flying. By taking off light and then loading in mid-air a plane can carry a materially greater load and thereby reach a more distant point safely.

Members of the Army endurance crew were all of the opinion that in the near future a system of aerial service stations will be inaugurated throughout the country, every large air terminal having a refuel plane to serve large passenger liners. Thus if a passenger plane finds bad weather ahead it will detour over the nearest clear refueling station take on fuel without stopping and continue by a longer route to the original terminal. A very practical point here is that by refueling often, a transport plane may carry less fuel and more pay load. By eliminating intermediate landing the wear and tear on the plane is greatly lessened and the element of danger which always enters into a landing is reduced in proportion as the intermediate stops are eliminated.

That aerial refueling will greatly speed passenger transport was demonstrated by two refuelings of the "Question Mark" during her flight to the west coast. Over Dallas, Texas, an aerial refueling was accomplished without delaying the plane more than seven minutes, which were used in circling the field and contacting the nurse plane. Continuing on to Tuscon, Arizona, the "Question Mark" landed for refueling by a good ground crew which was prepared to refuel quickly, yet the operation consumed 40 min., counting the time lost in landing and taking off. This is a clear gain of more than half an hour, in a fair test, on just one operation.

Having so definitely proved the advantages of aerial refueling, even with present crude equipment, Major Spatz visions the time in the near future when designers will build large transport planes especially for refueling and repair of engines in mid-air. These planes would probably be of 200 or 300 ft. wing spread, it is thought, with engines entirely housed and accessible to mechanics, propellers being gear driven. By using a somewhat longer hose any possibility of contact between the two planes in formation could be eliminated, and by periodically adjusting the engines before they begin to lose power the big plane could be kept in full flight across the country. Such large planes would probably be accommodated only at special terminals on each coast and would therefore eliminate entirely any intermediate stops.

Having noted the success of the "Question Mark" flight and the commercial developments which are indicated, it is interesting to study the equipment used on the recent endurance record.

The "Question Mark" is a standard Army Atlantic C-2A monoplane, known commercially as the Fokker F-7 ft. is powered by three stock Wright J-5 engines, each developing a maximum of 225 hp. and rated at 200 normal hp. The Atlantic C-2A is a high wing monoplane, 48 ft. 3 in. in overall length and with a wing span of 71 ft. 6 in. Height is 12 ft. 5 in., and weight empty 5,700 lb. The fuselage is of welded steel tubing, fabric covered; and the wing is of full cantilever construction plywood covered.

The Wright J-5 engines are nine cylinder, air cooled radials, weighing 500 lb. each and developing 200 hp. at 1,800 r.p.m., 225 hp. at 2,000 r.p.m., with a piston displacement of 788 cu. in.

The refuel planes, of which there were two, were Douglas C-1C Army transports powered with the Liberty 12 water cooled engine developing 420 hp. at 1,700 r.p.m. The Douglas is a cabin biplane with a 56 ft. 8 in. span, overall height of 14 ft. and overall length of 35 ft. 8 in. This plane weighs 3,880 lb. empty and 6,450 lb. loaded. The Atlantic C-2A cruises at 90 m.p.h. and has a high speed of 115 m.p.h. while the Douglas C-1C cruises at

100 m.p.h. and has a high speed of 121 m.p.h. Two Boeing PW-9D planes were also used for message carrying, being converted into "flying blackboards" by painting each side black and writing the message on the side in chalk.

Refueling Planes Fitted With Special Tanks

The Douglas refuel planes were especially fitted with three large cabin tanks for carrying a supply of gasoline and each also had room for several five gallon cans of lubricating oil and any incidental pouches of food or supplies. Aside from the fuel tanks and a 30 ft. hose which was dropped through the trap door in the cabin floor there was little special equipment on these planes. A block and tackle was rigged for lowering the cans and also to haul the hose up. The hose carried no valve on the lower end, there being a three way piping system in the refuel plane's cabin which permitted the operator to run gasoline from either or all of the three tanks as soon as the hose had been installed in the funnel on the "Question Mark" by Major Spatz. An additional item here was a copper wire running down the refuel hose and grounded on the "Question Mark" each time by Major Spatz in order to prevent static electricity from the hose firing the gasoline.

Because it was necessary for the "Question Mark" crew to live on board for a protracted period and keep the engines going constantly in addition to the work of refueling, there was considerable extra equipment installed on this craft. This equipment both loaded the plane down and added to its wind resistance materially so that it was under a handicap from this angle throughout the entire flight.

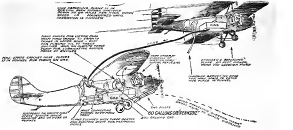
To provide comfort for the crew there were three folding Army bunks built into the cabin behind the main reserve tanks, two lower and an upper. There was also a folding table and sufficient writing materials to keep the entire crew busy during the time aloft. An electric stove had been planned as part of the original equipment but was left out in order to save space. In the forward part of the main cabin there were two large gasoline tanks carrying a total of 300 gal. of gasoline in addition to 280 gal. carried by the wing tanks. Gasoline reached these tanks from the refuel hose through the large funnel at the rear trap door by means of light aluminum pipes. These pipes could be taken down and hung on wall racks between refuelings. While refueling, Major Spatz took position on a raised platform in the entry way at the rear of the main cabin, his head and shoulders projecting through a large opening in the top of the fuselage made by sliding a trapdoor aside. After the cabin tanks were filled the gasoline was pumped into the wing tanks by means of a large hand operated wobble pump on the right forward side of the cabin. For this flight the Army used Richfield aviation gasoline exclusively, pumping all gasoline carried aloft from the Metropolitan airport into the refuel planes from a permanent Richfield aviation service station which has been erected at the runway intersection.

Oil Received in Five Gallon Cans

Oil was passed to the "Question Mark" through the trapdoor in the cabin roof, being received in five gallon cans and poured into a 60 gal. reserve tank in the main cabin. Penzoil triple extra heavy was the only engine oil used, and it was pumped to the engine tanks by means of a large hand operated wobble pump on the left forward side of the cabin.

Probably the most interesting part of the special equipment was that by which the Penzoil triple extra heavy in the engines and engine tanks was periodically drained and replaced by fresh oil, and the manner in which all rocker arms of all three engines were kept lubricated from the main cabin.

From the reserve supply of lubricating oil, copper tubes led to the three engine tanks, permitting these tanks to be filled at will. Valves were also provided at each tank by which they could be drained of old oil. On the nacelles these valves were located below and to the rear of the nacelle proper and were operated by torque rods connected to an indicating board within the cabin, one on the right side and one on the left, which told whether the valves were feeding oil to the tank, draining it out, or were in the closed position. Periodically the mechanic, Sergt. Roy Hooe would turn the oil drain valve from inside the cabin, drain out the worn oil, close the oil drain valve, open the feed valve and pump the engine tank full



A cross section drawing show how the refueling contacts were made during the flight of the "Question Mark"

with the wobble pump, thus keeping fresh oil in all engines throughout the flight.

For greasing the rocker arms a system of copper tube leads was installed, all of which terminated at a board in the forward part of the main cabin. There were three typical Alemite connections on the board, one connection for the pipe line leading to each engine. In order to grease the valve mechanism of any particular engine Sergeant Hooe simply connected an ordinary Alemite pressure gun to the proper terminal and shot Alemite grease through the pipe line to the rocker arms of the desired engine. The pipe line to each engine was divided between the upper two cylinders and lead in series from rocker arm to rocker arm each way around the engine until the lines joined at the bottom.

The starboard engine of the "Question Mark." Note the Westinghouse Micarta propeller, cat-walk below engine, Alemite pressure system tubing, and large lubricating oil lines from main cabin to nacelle.

In order that the engines might be reached while in flight an extra door was provided on each side of the cockpit. From this door a walkway led out to each engine. The walk was of steel tube construction braced to the upper longeron and to the nacelle at the forward end of the walk, and with a hand rail running along its rear side. A step was built on the landing gear just above the tire in order that mechanic might reach the outside of the engine. Just before the "Question Mark" landed Sergeant Hooe did go out on the left catwalk, get around the nacelle to the outside step and start work on the failing cylinders but rapid loss of altitude forced him to return to the cabin before being given an opportunity to perform any repairs.

A large platform of steel tubing was mounted below the nose of the plane around the forward engine. This is reached by climbing up through the pilot's cockpit and down over the nose. This platform was not used during the flight but provides an excellent footing in case of emergency. The mechanic going out on the catwalks is equipped with a safety belt which he can hook to the engine in such a way as to leave both hands free to work. The two side walk ways are covered with composition board while the forward platform is a simple grid of steel tubing.

The crew on the "Question Mark" consisted of Maj. Carl Spatz, in command, Capt. Ira C. Eaker, second in command and chief pilot, First Lieut. Harry A. Halverson, pilot, Sec. Lieut. Elwood R. Quesada, pilot, and Staff Sergt. Roy W. Hooe, mechanic.

Capt. Ross G. Hoyt piloted refuel plane No. One, and First Lieut. Odas Moon, piloted refuel plane No. Two. First Lieut. Auby C. Strickland, Second Lieut. Andrew F. Solter, Second Lieut. Irvin A. Woodring, and Second Lieut. Joseph C. Hopkins, were all members of the refueling crews.

During the progress of the flight Major Spatz was in charge of operations on the "Question Mark," issued daily orders to the crew, and at all times made the decisions as to the route to be flown, and procedure followed in emergency. Such an emergency arose when the entire coast of Southern California was blotted out by heavy fog on Thursday night, January 3, but Major Spatz ordered refuel plane No. Two to follow him to the Imperial Valley with a load of gasoline. Although the air was very rough over the Imperial Valley, making the night flying period there most difficult and at times dangerous, the visibility was good and Major Spatz was able

The "Question Mark" taking on fuel. Major Spatz is at the hose and Captain Eaker at the controls

to refuel twice during the hours of darkness before returning again to the Los Angeles Metropolitan Airport when conditions had improved on the coast.

An excellent idea of the duties aboard the "Question Mark" is given by the first order published aboard her by Major Spatz, and which reads as follows:

General Instructions:

(1) *Captain Eaker will be at the controls with Lieutenant Halverson assisting. Major Spatz and Lieut. Quesada will be at refueling point and Sergt. Hooe will be at the pumps.*

(2.) *Duty hours for piloting and flight officer will be published at daylight each day to cover the ensuing 24 hr., commencing at 6 A. M. on the day of issue.*

(3) *Pilots will normally fly course—Los Angeles Metropolitan Airport—Rockwell Field and return, rounding tower at Metropolitan Airport and wireless masts at Rockwell Field.*

(4) *In case of uncertain visibility of weather conditions or motor trouble or unusual circumstances of any nature should arise, Major Spatz and Captain Eaker will be notified immediately.*

(5) *In case of emergency requiring landing, Capt. Eaker will take the controls.*

(6.) *Capt. Eaker will be charged with winding the barographs.*

(7.) *The flight officer on duty will be responsible that the gasoline in the wing tanks is maintained at the proper level.*

(8) *The pilot on duty is responsible for switching the gasoline feed from one tank to another.*

(9) *Throttle setting will not be changed by pilots after having been determined by Capt. Eaker. Any condition requiring a change in throttle setting will be considered an emergency and paragraph four will be complied with.*

(10.) Sergt Hoae will be responsible for changing oil in the motors This change will always be accomplished while Capt. Eaker is at the controls

(11.) In case of emergency requiring jumping, the flight officer on duty is responsible that all members of crew are notified and are ready to jump before he leaves airplane Pilot will remain at controls until last man has left cabin unless mishap is of such nature as to render controls completely useless

(12.) Flight officer on duty is responsible that the proper entries are made as called for in instructions in log entries during his tour of duty

(Signed) CARL SPATZ,
Major Air Corps, Commanding

Lieuts. H W Keefer, Roger V. Williams and Archie Roth acted as pilots for the "Blackboard" messenger planes, and First Lieut Ray G. Harris was in charge of all preparation and servicing of the "Question Mark" for its flight The Boeing PW-9D "Blackboard" planes were sent up with special messages and with reports on the weather as determined by the Antar Deraga laboratory which was maintained in the operations tower of the Metropolitan Airport throughout the flight. Mail and all messages not sent up on the sides of the blackboard planes were placed with the meals which were regularly passed to the fliers Major Spatz communicated with his ground crew by dropping weighted messages with streamers attached On several occasions, particularly at night, these messages were almost lost, indicating that a light radio communicating set would probably be more nearly ideal for this purpose.

During the refueling operations Captain Eaker would fly the Fokker in normal level flight while the refueling plane came up from the rear and took position about 20 ft above the "Question Mark" and a very little bit ahead, usually with the tail skid about over Major Spatz's head Major Spatz completed the refueling connection by opening the trap door in the roof and standing on a raised platform with his head and shoulders out of the plane then as the 1½ in hose was lowered he would grab and shove it into the funnel which fed to the "Question Mark" reserve tanks, thereafter holding the hose in place until the fueling was completed Normally there was no perceptible variation in the distance between the two planes but on three separate occasions the refuel plane pulled away and showered Major Spatz with gasoline before the operator above was able to stop the flow.

It was interesting to observe, at the close of the flight, that oil drained from the three engine tanks had completely drenched the tail surfaces and rear of the fuselage.

A novel propeller combination employed on the "Question Mark" proved completely satisfactory Stock two blade Westinghouse Micarta propellers of 8 ft 10 in diameter were used on the wing engines while a special three blade Standard Steel propeller was mounted on the nose engine. This arrangement seemed more quiet than the usual propeller equipment and greatly added to the comfort of the crew Additional equipment consisted of Eclipse hand inertia starters, Pioneer instruments and fuel pump Willard 12 volt batteries and Goodyear tires

All Pass Physical Examination

At the end of the flight all members of the crew were given the Air Corps physical examination With the exception of normal fatigue, which was not as much as had been anticipated, all of the men were in first class condition, Major Spatz passing a better examination at the close of the flight than he had before the start

The other four members of the crew seconded Major Spatz's statement that he had enjoyed a six day vacation in the air Every angle of the flight strongly indicates the complete feasibility of keeping crews aloft for long periods and of indefinite refueling without undue effort or trouble, forecasting the very early application of these methods to certain phases of commercial flying

VENDORS' MATERIAL USED ON WRIGHT ENGINES No. 9447-9448-9449 OF THE QUESTION MARK

Parts	*Vendors*	*Address*
Valves	Thompson Products Co	Cleveland, Ohio
Piston Rings	American Hammered Piston Ring Co	Baltimore, Md
Ignition Wire "Airtite"	The Acme Wire Co	New Haven, Conn.
Outer Ball Bearings, S R D	Standard Steel & Bearing Co	Plainville, Conn
Rear Ball Bearings	Standard Steel & Bearing Co.	Plainville, Conn
Thrust Bearings S K F	S K F Industries, Inc	2004 Broadway, N Y C
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Valve Tappet Guide Rough Forging	Bethlehem Steel Corp	Bethlehem, Pa
Ex. Pipe Flange Rough Forging	Endicott Forging & Mfg Co	Endicott, N Y
Intake Pipe	Endicott Forging & Mfg Co	Endicott, N Y
Crankshaft Bearing Rear	American Tube & Bending Co	New Haven Conn
Aluminum Alloy	Bohn Aluminum & Brass Co	Detroit, Mich.
Gaskets	Aluminum Company of America	Pittsburgh, Pa
Counterweights	The Vellumoid Company	Worcester Mass
Alemite	Tioga Steel & Iron Co	Easton Pa

Uniflows were not installed on engine at factory

Short Distance Racing *and* Handicapping

By Lady Mary Heath

As one who has "suffered" much from the loss of the odd second in short distance races, and has worked hard to catch up on the allowances, the work of the man behind the scenes has always much intrigued me.

The handicapper is everyone's whipping post Everyone comes to him with grievances and imagined wrongs, and he has usually a very hard time to straighten everything out

It was of great interest to me, therefore, some little time ago to nail down our official British handicapper, Mr Goodman-Crouch, now in this lovely country, in this reciprocity business, and to pick his brains a little Mr Goodman-Crouch is one of the most important member of the Civil Flying Department of the Air Ministry, and for many years has been in the Research Department at Farnborough when he was not engaged in officially handicapping for the Royal Aero Club

It has always amazed us racing pilots how he can ferret out our humble efforts in hoodwinking him by reducing load and resistance, by cutting out, droop, by exchanging cylinder head gaskets for brown paper dipped in goldsize and in other ways trying to "get past him." That we are all still on speaking terms after a couple of seasons including well over a hundred races —mostly with a bunch of four or five splitting seconds across the finishing line—speaks volumes for the efficiency and the fairness of his work

Action picture of a DH "Moth" winning a light plane handicap race held in England

Handicapping means real hard work It means taking in the official reports of every air race all over the country, to keep in touch with the performances of machines and pilots all through the season. It means watching the performances of machines that go outside of the country and compete abroad It means giving up, perhaps the hardest condition of all, the cheery evening spent in aviation small talk with a dozen boon companions the night before a race or a race meeting and it means the closest scrutiny of every machine on the day of the race to see that it fulfills its declared conditions of weight, and streamlining, etc, before it goes out to the starting line It means, above all, a display of race tact, as, for instance, when the man possessed of a 200 hp pursuit plane solemnly expects one to believe that it will not do more than 40 m p h

For air races, handicap allowance is arrived at by the following means:

It is necessary to know the speed of each machine, founded on some recognized basis, such as actual performance, i e —

(a) Known speed or estimated speed
(b) Speed that should be obtained by the application of the recognized formula

Whichever of these means is applied, and they will be described later, the manner in which the handicap allowance is obtained, is the following:

The machines are put put down in order of speed in column four*, starting at the slowest The second column is made to contain the times estimated on those speeds which will be taken for completing the course Corrections are then necessary, which will be made in the third column

The corrections can, of course, be equally well made on the speed basis. That is to say, the original speed estimated, or known, can be modified to take into account the meteorological conditions, the turning points in the course and other considerations of like nature

For instance, it is obvious that a machine which is capable of 200 m p h in level flight will certainly attain a very much reduced speed when flown over, say, a triangular course of short lap length This reduciton of speed is greater in the case of fast machines than slow ones, since a greater distance is flown

Meterological conditions are taken into account, and it has been the practice in English racing never to publish the final handicap allowances until the morning of the races so that the latest weather reports may be taken into account when introducing the weather factor.

Before talking about time for the course, the speeds

* See table on page 164

of the air craft being thus adjusted, it is a simple mathematical problem to work out the estimated time taken by each machine to cover the lap, or if the race is not flown in more than one lap—the entire course

It should perhaps be mentioned that the actual measurements of the course and distance are extremely difficult, and the results of one race can only be used as a basis for estimating speeds over a separate course on a relative basis This is mostly due to the extreme difficulty of obtaining the exact length of any leg, or course, and a variation of 10 m p h has often been found in the results obtained by the most accurate timing, due entirely to this cause

From the time taken to fly the course (see column 2), the time taken from zero, or starting time (see column 3), is then obtained For instance, if the slowest machine, or "limit man," takes three hours and the fastest, or "scratch man," takes one hour, the "limit man" is placed at zero starting time, while the "scratch man" is placed at two hours behind zero hour.

The actual handicap allowances (see column 4), which are posted up for public information prior to race, are then obtained by the reverse process, i e, that of subtracting the estimated time taken for the course by the scratch man from the times taken by the other competitors

The resulting table then is as follows:

1. *Speed of air craft in m.p.h.*	2. *Estimated time for lap or course*	3. *Time from zero or starting time*	4. *Handicap allowances.*

The above is obviously a simple mathematical process and it remains to discuss the actual method of which the estimated speeds are obtained.

There are two main headings under which this work falls

1. That of estimating, as nearly as possible, the actual speed contained by the aircraft considered This may be done (and this is the simplest method) by a knowledge of the actual performance on some previous occasion of the aircraft in question

Here again it is necessary to bear in mind the fact that these factors have to be considered

(a) The fact that the speeds quoted from previous timings can only be considered as relative to one another, due to the human element in course measurement

(b) The fact that these speeds may have been obtained by pilots of varying racing capacity

(c) The fact that the weather conditions on the varying occasions considered, may not have been consistent

Of the above three conditions, the second possibly is the only one which requires explanation

Speed Considerations Important

It will be readily realized that if one aircraft is continuously flown by a pilot of exceptionally good racing capacity, the times obtained will be better than those which would have been obtained by a racing pilot of normal capacity Since the above method is only employed when it is desired to give the prize to the best pilot, it is only right that all considerations bearing on the speed of the aircraft should be taken into account, the necessary corrections being made for piloting skill, which on former occasions had led to success

It should be pointed out that when this method has been employed in air races in Great Britain, the official handicapper has always made a point of noting, during all races, the number of seconds lost on turning points within sight of the airdrome at which he is stationed

This method then leads to the prize being gained purely and solely by the piloting skill of the one in charge of the machine, and this method in the same way leads to the extremely close finishes which give the finest element of sport that has characterized air racing in Great Britain

2 Now it is obvious that it may be desirable to give a prize to aircraft designers who are capable of reducing the parasitic resistance to the utmost minimum, or

A typical scene at any air carnival held in England, showing the crowds that gather at such events

Lined up for a heat in a recent handicap race. The author's plane, second from right, won the race.

possibly to engine designers who are capable of obtaining the best power to weight ratio

In this case, a formula is used for obtaining the speeds on which the handicap allowances of the race are based Any suitable formula can be used for this purpose, according to the ideas of the promoters One such formula, which has been used in England, has been based on the span and the weight of each competing plane This has led to interesting results

A Premium on Freak Machines

It must be borne in mind, however, that this second method places a premium on freak machines which are designed to defeat the formula. Moreover, close and sporting finishes cannot be hoped for, as it is a matter of coincidence, of quality or design, if two machines happen to cross the finishing line together

These two methods for obtaining the speed, which is placed in the first column of the table, are the main ways in which this work is carried out.

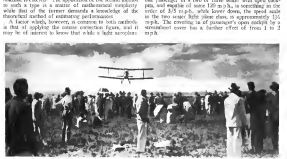
It is, of course, a fact that very often a new type of machine is entered The application of the second method to such a type is a matter of mathematical simplicity while that of the former demands a knowledge of the theoretical method of estimating performances

A factor which, however, is common to both methods is that of applying the course correction figure, and it may be of interest to know that while a light aeroplane such as the "Moth" or "Avian," is capable of a speed on a straight course in level flight of about 100 m p h, it is reduced to a figure of approximately 93 m.p h. when flying on a triangular lap with a total length of five miles. A machine such as the Avro "Avenger," which approximates 200 m p h. in straight flight, is reduced on such a lap to a figure in the neighborhood of 170 m p h

If it is desired, however, to hold race meetings at which the prizes are to be given for the best piloting, it is advisable to use the first method of obtaining the speeds on which the handicap allowance figures are based, while if it is desired to give prizes for aircraft design, or for engine boosting, the second method with an appropriate formula, is suitable

Before the estimation of speed with regard to figures under column one, it is, of course, necessary to bear in mind the effect of passengers, not only as regards their weight, but also as regards the resistance of their heads and shoulders in machines with open cockpits, while the streamlining of struts and fittings must also be taken into account.

For instance, the effect of the weight and resistance of one passenger in a two or three seater with open cockpits, and capable of some 120 m p h., is something in the order of 3/5 m.p.h. while lower down, the speed scale in the two seater light plane class, is approximately 1½ m.p.h. The covering in of passenger's open cockpit by a streamlined cover has a further effect of from 1 to 2 m p h.



The author winning her first Trans-African race, held at Johannesburg

Plywood *in* Aircraft Construction

By JAMES R. FITZPATRICK
Vice President, Haskelite Manufacturing Corp

FROM the very beginning of man's efforts to fly, wood has played a major part in the construction of successful flying machines. Both light weight and exceptional strength are required for airplanes, so it was natural that the early builders turned to wood and, as the design improved and more complex problems arose they turned to plywood for many structural purposes.

Plywood as first used was not waterproof and consequently was not suitable for service in all kinds of weather. During the World War however, the Government found and successfully tested a really waterproof plywood, which had been developed for use in canoes. The plies of this plywood were attached to each other with a blood albumen glue, which produces an all weatherproof material, capable of being formed into various curvatures without injury to the glue or the product. Huge quantities of it were used by the Government in airplane construction. Every test possible was applied to the finished plywood to insure that only the best reached the finished plane, thereby increasing the factor of safety.

Plymetl a Post-War Development

The Haskelite Manufacturing Corp., at Chicago, Ill., played an important part in supplying the government demands and today its factories turn out plywood and Plymetl which are known and tested in many industries. Plymetl is a steel or metal-faced plywood developed after the war in response to a demand for a plywood which had exceptional resistance to impact. A method was worked out for gluing thin metal faces to the weatherproof plywood and the resulting combination was termed "Plymetl."

At the main plant in Grand Rapids, great quantities of high grade veneer, from which the plywood is to be made, are stored in large warehouses. When veneer is cut from a steamed log, it is necessary that it be thoroughly dried before it is used. On receipt of a shipment of veneer at a Haskelite plant, the first thing done is to dry it in great large oscillating hot plate redriers, not only reducing the moisture content, but leaving the pieces of veneer substantially flat. Since the veneer as received contains numerous defects due to careless cutting or defects in the log, it is necessary that these imperfections be cut out. This is done at the Haskelite plant by large clippers which trim each piece to a width free of defects and to one of a

A section of the Grand Rapids, Mich., plant of the Haskelite Manufacturing Corp

number of standard lengths. The pieces thus dried and clipped are passed to the stock room, where veneers of the same kind of wood, same thickness, and same length are kept together.

Very large storage is necessary for the veneer in order that an ample supply of dried veneer of the proper kind, size, etc., be on hand at all times. Not only are many different kinds of wood veneer stored, but each kind must be available in a large number of sizes, widths, thicknesses, and lengths.

When an order is received to make a set of panels

The main plant of the Haskelite Manufacturing Corp at Grand Rapids Mich

Two interior views of the Haskelite Manufacturing Corp factory at Grand Rapids, Mich

of a certain material, size, and so on, sufficient veneers are withdrawn from stock and placed upon a movable platform. The length of these veneers withdrawn are generally correct, but their edges have to be made straight and perpendicular to the faces. This work is done by jointer machines. The various veneers are then sorted to make the several plies of the different panels wanted. Usually one piece has to be cut narrower to make the proper total width.

Following the sorting, the veneers for the face plies are sent to a taping machine which holds the veneers together by pasting a thin paper tape on the faces with the edges butted together. In this way each panel is assembled to the desired full size. Great pains are taken at the Haskelite plant to eliminate any small stresses which might be set up between the plies. Core plies are thoroughly dried after their faces have been coated with glue, but the glue is not set by this drying process. After this is done, fresh glue is spread on the backs of the two face plies that form a single panel, and these are placed above and below the core so that the grain of the plies runs at right angles to the grain of the core. The edges of the assembled veneers are coated with Haskelite glue, and the plies so assembled are placed in larger presses, whose steam heated plates are 5 x 8 ft. in size, to be unified by pressure and heat.

In order that the very best results can be secured, all plies of the panels are very dry just before the glue is spread on them. Also, the time between the application of the glue and the pressing operation is very short so that no ply has a chance to absorb moisture. This procedure eliminates the chances of the plies shrinking and producing initial stresses which are common with man-gluing systems. The moisture of the glue spread on the face plies soaks up the dried glue on the core so the glue between the plies has the right consistency for producing a highly waterproof joint. The gluing press consists of smooth faced hollow plates heated to 2f0 deg. by steam circulating through the plates. Plies to be glued together are placed between two of these plates and hydraulic pressure applied. The pressure used is adjusted to the size of the panel and the pressure required per square inch of the panel surface. During the pressing, heat penetrates the plies, setting the glue and producing a thoroughly unified plywood.

Following the gluing and pressing, the panels are carefully planed to insure an absolutely uniform thickness. This point in the preparation is particularly important for airplane manufacturers as they require uniform thickness in the materials they use. Usually the panels are about two inches oversize all the way around and before stored, these edges are trimmed off. Finished panels intended for flat work are stored flat in the drying room, but panels intended for curving are sent to the molding department for that operation.

In molding Haskelite plywood, it is first actually boiled in vats to soften the wood. The blood albumen glue reveals its ability in this process, for it retains its properties and when the molding process is completed, the finished product is just as waterproof and just as well unified as the original flat panels.

In addition to carrying huge stocks of plywood and Plymetl, the Haskelite Manufacturing Corporation carries on extensive research and testing of these materials. Massive as well as delicate testing machines are employed constantly in making actual tests on all sorts of woods and plywood. These tests include tests in column-bend-

Stocking Haskelite plywood at the main plant at Grand Rapids

ing, tension strength, splitting resistance, shearing strength, cupping tendencies, twisting tests, determination of elasticity, and many others. Results of thousands of these tests have been tabulated and provided in convenient blue print form for the convenience of users.

Primarily the business of the Haskelite Manufacturing Corp. was the production of airplane plywoods and Plymetl. Scores of other uses have been found for these materials as the light weight, strength and waterproof qualities have proven valuable in the manufacture of automobile roofs, truck bodies, marine bulkheads, etc.

Notes on Protection of Wooden Propellers

By Chase S. Story

DUE to the fact that the performance and income of the airplane depends so greatly upon the condition of its propeller, or propellers, every precaution should be taken to prevent costly repairs and tie-ups during the rainy season

The wooden propeller requires more care and attention than other types There have been numerous cases in the history of wooden propellers where a spinner, or even the propeller itself, would burst in the air due to the action of the weather in soaking up unprotected portions of the wood. Rarely indeed is there any record of a propeller that had been properly inspected and protected failing in flight

To protect the wooden propeller from watersoaking, first make sure that the propeller is dry If damp it must be very slowly dried in a warm dry room, the process extending over several days depending upon the amount of water which has been soaked up When the propeller is dry, remove the hub and give the hub hole two coats of spar varnish or waterproof paint Use plastic wood well pressed in, to fill cracks between the wood spinner and the propeller Next touch up all places on the blade where the finish has been scarred leaving bare wood, especially on the back side of the blade where sand cutting is greatest If possible, two coats of spar varnish or high grade enamel should be applied to the propeller The finish should be applied as evenly as possible in order not to affect the balance, and particular care must be taken that the varnish does not run or sag, caused by too heavy application Do not attempt to varnish over lacquer finishes Propellers with lacquer type finish must be sprayed by persons well familiar with the process.

Should Keep Leading Edge Touched Up

When complete refinishing is necessary, from seven to nine coats are required to withstand possible flying through rain. It pays to keep the leading edge touched up when it is not protected by metal tipping

It must be remembered that for any given amount of finish which is added to one blade an equal amount must be added to the corresponding place on the other blade in order to keep within reasonable balance.

On the ground, the greatest menace to the propeller is the person who, unable to place his plane under cover, carefully wraps up the propeller with burlap, canvas, oil cloth, etc. In the first place when the airplane is at rest on the ground, or has been stored away, even in a well-protected hangar, always leave the propeller in a horizontal position The reason for this is apparent in the varying temperatures found in a room at altitudes sometimes as little as two or three feet apart, while outdoors there is almost always an area of high humidity close to the ground and if the propeller is allowed to remain at rest with one blade closer to the ground than the other, the lower will almost certainly absorb more moisture

In the second place, never wrap a propeller in anything which can become saturated with water, or which can catch and hold water or moisture in such a way that it will be against the propeller blade Particularly is this true where close fitting spinners are used A propeller without covers will quickly drain off and dry after a storm, but one wrapped up in wet fabric which will remain damp for days, may absorb enough water to become out of balance or even to open up glue joints to a point where the propeller will fail at high r. p m

No Water Collecting

The best propeller cover is one made of waterproof auto top or some such rubberized material, perferably without seams on top, and open from end to end along the lower edge with snap buttons along this edge to safety it Water cannot possibly collect in this type as it sometimes does in other standard or homemade propeller covers, especially those in which one end is sewed up to slip over one blade of the propeller, while the other end is provided with snaps

Great care must be taken that no water be allowed to collect about the spinner as it may seep through minute holes or cracks into the interior and open up the glue joints in the hub of the propeller If sufficient water collects inside a built on wood spinner it will literally blow the spinner apart from centrifugal action at high r. p m. in some cases

The last important thing to do is to inspect the extreme ends of the metal tipping and open up the vent holes for draining out oil and moisture that occasionally works out under the metal There should be at least three 1-32 in holes provided for this purpose. Failure to see that these drain holes are provided and kept open will usually result in the metal swelling out from the wood and throwing the propeller badly out of balance from centrifugal action, which has been great enough in several instances to strip off the metal tipping, badly damaging both the engine and the plane

Before remounting the propeller for flight work it is essential that it be balance tested again, no matter how carefully the finish may have been applied There are many very accurate propeller balancing racks in use about the country but if none of these happen to be available it is quite possible to rig up a home-made balance stand that will be sufficiently accurate to check the propeller before again placing it in service

Aeronautics Branch Licenses 4,690 Pilots

WASHINGTON, D C—There were 4,690 licensed pilots in the United States and territories on January 1, which figure, when increased by those who have been temporarily permitted to pilot planes shows approximately 5,200 pilots authorized by the Department of Commerce, according to figures compiled by its Aeronautics Branch. Of the 4,690 licensed pilots, 2,927 are transport, 532, limited commercial, 66, industrial, and 1,165, private Included among the 4 690 were 34 women of whom two have transport pilot licenses six, limited commercial licenses and 26 private licenses.

California led the states in the number of licensed pilots, having 894 followed by New York with 472 The other states which have more than 100 licensed pilots as of January 1, are Illinois with 280, Michigan, 249, Pennsylvania, 239 Ohio 228, Texas, 218 Missouri, 178, District of Columbia, 165, Virginia, 117, Massachusetts, 109, and Wisconsin, 101

In addition to the above, the Commerce Department licensed four pilots intending to fly in Canada, three in New Zealand, two in the Philippines, and one in each of the following Canal Zone, Egypt, Nicaragua and Paraguay

Pilots by States

Licensed pilots, according to states, are listed as follows

Alabama 35 Arizona 13, Arkansas 42 California 894 Colorado 73, Connecticut 44 Delaware 6 Dist of Col 165, Florida 75, Georgia 35, Idaho 12, Illinois 280 Indiana 86, Iowa 55, Kansas 94 Kentucky 33, Louisiana 35, Maine 7, Maryland 44 Massachusetts 109, Michigan 249 Minnesota 97, Mississippi 17, Missouri 178 Montana 22 Nebraska 45, Nevada 8, New Hampshire 5, New Jersey 88, New Mexico 4, New York 472, North Carolina 28 North Dakota 7, Ohio 228 Oklahoma 81 Oregon 48, Pennsylvania 239 Rhode Island 7, South Carolina 12, South Dakota 17, Tennessee 59, Texas 218 Utah 29, Vermont 5 Virginia 117, Washington 97 West Virginia 14 Wisconsin 101, Wyoming 27, Alaska 9 and Hawaii 25

Guardian Control to White

ST LOUIS, MO—Derek White has announced his resignation as general manager of the Parks Air College, although he is retaining his interest in the business According to his announcement he has purchased the controlling interest in the Guardian Airseater light plane

Loening Deliveries Made

NEW YORK N Y—Announcement is made by Albert P Loening vice president and general manager of the Loening Division of the Keystone Aircraft Corp., that Pan American Airways, Inc, has accepted delivery on two more Keystone-Loening Air Yachts.

Name Lindbergh Technical Adviser of P. A. A. Services

Will Fly First Mail Consignment to Canal Zone In Miami-Cristobal Line Opening

NEW YORK, N Y—Col Charles A Lindbergh now states that he has been retained as technical adviser by Pan American Airways, Inc, and its affiliated operating companies, and also as consultant to the Aviation Corporation of the Americas, the holding company The announcement came in an interview granted by Colonel Lindbergh and J T Trippe, Pan American firm president, in which it was explained that the Colonel will in the future pass on all matters pertaining to routes, airports, equipment, etc., relating to the Pan American service It was pointed out that the new duties of the trans-Atlantic flier in no way interfere with his advisory position with Transcontinental Air Transport, Inc

Pan American Airways planned to institute service between Miami and the Panama Canal Zone on January 11, as stated in the last issue of this magazine, but with the new association of Colonel Lindbergh it was decided to postpone this inauguration until February 4, at which time the Colonel will fly the first consignment of mail over this fourth foreign mail route of P.A A. It is said a Sikorsky S 38 will be employed in this initial flight.

Interrogated concerning his new connection, the Colonel stated he would work with Pan American "in the hope of bringing inter-communication with the South American Republics closer than is now possible."

Route Outlined

The itinerary of the trip to the Canal is as follows Miami, Fla., Havana, Cuba, Belize, British Honduras, Tela, Honduras Corinto, Nicaragua, Managua, Nicaragua, Puenta Arenas, Costa Rica, David, Panama and Cristobal, Canal Zone

In his capacity of T A T adviser, Colonel Lindbergh left Mitchel Field, L. I, January 12 to make an inspection tour of the company's transcontinental air-rail route He flew in the new Ford plane "Columbus," accompanied by Charles Goodfellow of the Curtiss Flying Service, and John Collings T A T pilot

Curtiss Service Buys Hartford, Conn., Firm

HARTFORD, CONN—The newly-formed Curtiss Flying Service of New England, a subsidiary of the Curtiss Flying Service, has bought the interests of the New England Aircraft Co and its subsidiary, the New England Flying Service, it was learned January 10 The new service has also leased a space at the East Boston Airport and will erect a hangar there soon, and will have the entire management of the Worcester Mass., airport

The Curtiss Flying Service of New England will operate from Hartford Worcester and Boston, carrying on pilot instruction, air taxi service, sight seeing service, aerial photography, and aerial advertising The Curtiss Flying Service is now operating from its new field at Bridgeport, Conn. In addition to its regular commercial service, the new company will be distributor for Curtiss, Sikorsky, and Ireland planes

Stinson Plans Attempt At Endurance Record

DETROIT, MICH—Eddie Stinson, president, and Randolph G Page, chief test pilot, of the Stinson Aircraft Corp., will attempt to break the world's record for non refueling endurance flight during February, it was learned here recently

The attempt, according to William A Mara, secretary of the corporation, who confirmed the report, will be made, if possible, either on the ice of Lake St Clair, near Selfridge Field, or from that of Saginaw Bay Should weather conditions in Michigan be unsuitable, Stinson will again take off in Florida.

Schedule New York Session

NEW YORK, N Y—Mayors of 10 upstate cities will be guests of Mayor Walker in the next session of the New York State Aviation Conference, scheduled to be held in the Aldermanic Chamber, City Hall, February 6

Guggenheim Fund for Chile

NEW YORK, N Y—Believing that South America offers great opportunities for air transport, Daniel Guggenheim, it is reported, has provided a fund of $480,000 for aviation development in Chile where the Guggenheim family has nitrate and copper producing interests It is said that the offer has been accepted but the terms have not been announced While Chile will be able to use the fund as it sees fit, it is understood that Mr Guggenheim hopes an endowed training school will be established Daniel Guggenheim's gifts for the development of aviation are already said to total more than $3,000,000.

Chapman Airliner Tested at Newark

Burnelli Plane is Powered by Two Geared Conqueror Engines

NEWARK, N J—First official test flights of the 20 passenger Chapman airliner were conducted recently at Newark Airport by Lieut Leigh Wade This airplane is an all metal, externally braced, monoplane designed and built by Vincent J Burnelli for P W Chapman and owned and operated by Sky Lines, Inc A series of cross country trips are planned to follow the completion of trial flights.

Four flights were made on the first day of the tests during which Lieut Wade was assisted by E F Stewart. On the first flight the plane took off in 440 ft. and in 6 sec and climbed to 3,000 ft. in 7 min, with engine throttled down In the second trial flight the plane took off with the two pilots and five passengers in 7 sec in a run of less than 300 ft On the third and fourth flights 12 passengers were carried and the plane took off in 9 sec. The landing speed was approximately 50 m p h.

Fuselage An Airfoil

The Chapman airliner is an all metal plane of unusual design with a fuselage having a true airfoil section which is said to contribute to the lift of the plane The wing structure is of the transverse stringer type of construction without ribs and having drag trusses at intervals in the structure Corrugated duralumin sheathing is used for wing and fuselage covering The plane is powered with two Curtiss Geared Conqueror engines each developing 600 hp at 2,400 r p m The engines are mounted side by side with radiator between in what might be called the leading edge of the airfoil shape which constitutes the fuselage.

The Chapman airliner has a wing span of 90 ft and a 14 ft chord The overall length is 47 ft The weight of the plane empty is 8,700 lb and the useful load 4,000 lb The estimated high speed is 145 m.p.h and cruising speed 115 m p h.

The cabin which is 18 ft long by 11 ft. 4 in wide, is roomy and is furnished with upholstered swivel chairs In the center of the forward portion is a lounge which is built over the main fuel tank Abaft the cabin are a toilet room and kitchen. The cabin is insulated against weather and engine noises and is fitted with electric lights and radio receiving equipment Forward of the cabin and accessible from it or through openings in either side of the fuselage is the control compartment which is completely equipped and so placed as to afford excellent visibility for both pilots

To decrease parasite drag a retractable landing gear is provided The mechanism for this consists of a system of cables and pulleys which are wound on a drum by means of a crank in the control compartment Two gasoline tanks of 280 gal capacity each are built into the wings and the cabin tank has a capacity of 440 gal

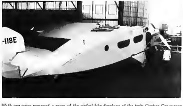
Aviation School Seeks Imposter

KANSAS CITY, MO.—A reward of $100 for information leading to the arrest of an impostor who recently victimized a score of prospective flying students in South Carolina and Georgia is offered by Dr. George L Bennett, director of the Bennett Flying Schools, with main offices at 217 West 14th Street, this city.

Using the name "Capt. James C. Hall," the man whose apprehension is desired is alleged to have absconded with money collected as down payments for tuition in what he called the "Bennett Memorial Flying School."

Named Travel Air Dealer

EUGENE, ORE.—Hobi Airways, this city, has been named Oregon distributor of Travel Air planes, it is announced



With one wing removed, a view of the airfoil-like fuselage of the twin Curtiss Conqueror powered Burnelli is afforded Note the construction of the empennage

Gates-Day Company Changes Firm Name

PATERSON, N. J.—Official announcement is made that the name of the Gates-Day Aircraft Corp of this city has been changed to New Standard Aircraft Corp. The firm manufactures the New Standard sesquiplanes

Changes in personnel were also announced, principal among which was the resignation of Ivan R Gates as president and member of the board Ill health was the reason advanced by Mr Gates for his severance of connection with the company Charles L. Auger, Jr., and Felix J Pettit were elected to the board of directors, George H Dawes, secretary and advertising manager with the firm, has been placed in charge of New Standard sales, and G Wilson England is cooperating in this work Management of the factory, furthermore is being undertaken by Charles F Rupprecht

Charles Healey Day, chief engineer and designer stated he would announce plans for a new dual engined transport plane in the early Spring Meanwhile the New Standard engineering force is working on the specifications and details of the proposed new plane

Production of the New Standard sesquiplane which is now in units of 10, will be increased to units of 25 when work begins in the corporation's new factory The new factory which has triple the amount of floor space as the present building was recently purchased for $100 000 Since then the work of installing electric equipment, boilers, and heating equipment has been under way The corporation's production schedule will start in the new plant about January 20

Fairchild Export Sales $193,000 in One Week

FARMINGDALE, L. I—Export sales of airplanes totalling $193 000 in one week are announced by the Fairchild Airplane Manufacturing Corp of this city Eight stock Fairchild monoplanes with spare parts and accessories are represented by the figure. They are to be placed in a variety of commercial services in widely differing climates and countries and under diversified conditions

Three were bought in Canada by the Dominion Explorers, Ltd., two in Mexico by the Compania Mexicana de Aviacion, one in Peru by the Peruvian Airways, Inc, one by Chilean Airways, Inc., and one by Pan American Airways at Costa Rica

Prize for World Flight

DENVER, COLO—A $50 000 prize has been offered by the Denver *Post* for the crew of the first airplane to make the first non-stop flight around the world following as closely as possible the 40th parallel, north latitude, and ending and starting at this city The offer remains good until Jan 1, 1931, and is open to any pilot in the world

Whitaker to Organize Szekely Sales Force

HOLLAND MICH—John T Whitaker, who for the last two years has been aeronautical and automotive engineer for the Tide Water Oil Sales Corp, has become vice president in charge of sales of the O E Szekely Aircraft Corp, it has just been announced by officials of the aircraft concern. In his new capacity, Mr Whitaker will undertake to organize the sales personnel, and will establish a field service organization, as well as distributing agencies for the planes and engines manufactured by his company

Mr. Whitaker was one of the first American students of Louis Paulham, under whom he learned to fly in California in 1911, and since that time he has been in active contact with the industry During the war, he served with the special intelligence service of the French Air Corps His activities since that time include a circuit tour of the United States made by plane in 1927 for the purpose of increasing the interest of the public in aviation and to encourage municipalities in establishing, adequate landing fields On this trip, he interviewed officials of the Los Angeles *Examiner*, and is said to have been responsible for the starting of a special aviation supplement by the paper, the first of the Hearst group to adopt this scheme Mr Whitaker's work with the Tide Water Oil Sales Corp is equally well-known

John T Whitaker

Florida Cities See Dirigible

MIAMI, FLA—The dirigible Los Angeles which was scheduled to fly over the Miami Municipal Airport as part of the dedication ceremonies held last week, did not make the flight until Sunday, January 13 At that time the ship flew over Miami and a number of Florida cities Weather regarded as dangerous was the cause of the delay

Stromberg Production Up

CHICAGO, ILL.—Stromberg carbureters for aircraft are to be manufactured on a large scale, according to C W Stiger, president of the concern This branch of the operations of the Stromberg firm, which did not begin to show a profit until the latter part of 1928, now promises to be at least a third of this year's business The plant has a capacity of 5 000 carbureters a day and it is expected production will average about 4,200 a day

New Aviation Finance Concern Is Organized

NEW YORK N Y—Formation of Aviation Business Bureau, Inc, which plans to carry on extensive research work and to offer a confidential weekly service to those interested in aviation finance, has just been announced by Dr Frederick L Hoffman, who has been consulting statistician for a large insurance company for the last 30 yr and is director of research for the new firm.

Dr Hoffman is known for his research work and statistical investigations, as well as for his interest in aviation He has made a great number of flights both here and abroad, and is said to have flown 20,000 mi. by plane In the near future, he contemplates a trip to the West Indies over the routes of Pan American Airways, Inc

Aside from Dr Hoffman, the personnel of the new concern includes Col Harold E. Hartney, Charles H Payne, Maj William J Hammer, Maj J B Lent and John W Bishop Mr Bishop will be in charge of the editorial work for the company and will also handle the sales of service, according to the announcement Offices are being maintained at 72 Wall Street, New York

Delivering Command-Aires

LITTLE ROCK ARK—Production on 369 planes ordered during the Chicago show is well underway at the Command-Aire plant here Four OX-5 craft, making the fifth since signing at the show, were recently delivered to the General Aviation Co at Syracuse N Y, the Aviation Service and Transport Co., Chicago, has received its first plane, and another has gone by freight to Northwestern Air-Lines Inc, Seattle. With seven planes delivered earlier this year, a good 1929 start is reported

Plane's Accessories Stolen

NORMAL, ILL.—Report of a theft at the Bloomington Airport is made by H A Mill, field manager Left on the airport the night of January 4 a Stearman plane was stripped of two landing lights, two Scintilla magnetos for the J-5 power plant, one compass, several spark plugs, one altimeter, one bank and turn indicator, airspeed indicator, clock, some flares, two flying suits, helmets, and goggles

Manufacturers Enter Craft in Detroit Show

DETROIT, MICH—Thirty-seven manufacturers have entered a total of 71 airplanes in the second annual All-American Aircraft Show, to be held here April 6-14, according to the latest announcement of Edward S Evans, chairman of the show committee, Aircraft Bureau, Detroit Board of Commerce Space reservations made by accessory manufacturers, the figures show, totalled 63 on January 10

Following is a list of aircraft entries received up to January 10

Advance Aircraft Co., Alliance Aircraft Corp, Aeromarine Klemm Corp, Aircraft Development Corp, American Eagle Aircraft Corp, Bellanca Aircraft Corp, Berliner Aircraft Co Inc., Buhl Aircraft Co., Butler Aircraft Corp, Cessna Aircraft Co, Chance Vought Corp, Cunningham Hall Aircraft Corp, Curtiss Flying Service of Michigan, Driggs Aircraft Corp., General Aircraft Corp by its distributor, Wolverine Flying Service Hamilton Metalplane Co, Invincible Metal Co., Kreider-Reisner Aircraft Co., by Skyways, Inc., E M Laird Airplane Co, Lenert Aircraft Co., Mahoney Ryan Aircraft Corp by Knapp Flying Service, Metal Aircraft Corp., Mohawk Aircraft Corp Moth Aircraft Corp., Overcashier Aircraft Corp., Pitcairn Aviation, Inc, R A. Rearwin Airplane Co, Swallow Airplane Co Swift Aircraft Corp, Stearman Aircraft Co by Skyways, Inc, Simson Aircraft Corp Stout Metal Airplane Co Swallow Air-Aircraft Corp., Spartan Aircraft Co, and the Travel Air Manufacturing Co

Planning Production Of Lycoming Engine

WILLIAMSPORT PA—Plans are now under way for production in the near future of an aircraft engine by the Lycoming Manufacturing Co The first model, which is a nine cylinder, air cooled static radial type, has undergone preliminary tests and soon will be under production and other models will follow The Lycoming engine was exhibited for the first time at the recent Automobile Show in New York City

The new engine is a conventional design and is rated at 185 hp at 1900 r p m It has a bore of 4½ in and a stroke of 4½ in giving a piston displacement of 645 cu in The overall length of the engine is 37 11-16 in, the overall diameter 43¼ in., the diameter of mounting ring 19¼, and the weight complete 470 lb A Stromberg carbureter and a dual Scintilla magneto are used.

Places Large Dural Order

MARSHALL, MO—The Nicholas-Beazley Airplane Co, Inc., this city, has placed an order with the Aluminum Company of America, New Kensington, Pa., for duralumin sheeting sufficient to manufacture 100 planes of the Barling NB-3 type

Plane Licensing To Be Changed

Special Cards Will be Issued All Owners; Metal Plates to Go

NEW YORK N Y—Adopting a system similar to that employed by some states in the registration of automobiles the Aeronautics Branch, Department of Commerce is instituting a new method for licensing aircraft which will be placed in operation within the next two months, according to a statement issued by the Aeronautical Chamber of Commerce.

The system embodies a number of features, which make it highly advantageous and in keeping with the progress of aviation the statement says. In addition to expediting the licensing of aircraft, all registrations will be more closely controlled as a result of the elaborate cross filing system that is a part of the new method

New Form to be Issued

Metal plates in the planes will no longer be used When a number is assigned by the Department, whether it is a license, temporary, experimental or indentification number, a card describing the aircraft will be issued This will be displayed or carried in the plane Besides this, the Government will issue a "record, transfer and reassignment" form, which the recorded owner will keep in his possession.

In case the title of the plane is transferred, the vendor, that is the operating agency, endorses the card carried in the plane, giving his name, the name of the purchaser and the date of the sale The "bill of sale" portion of the record, transfer and reassignment form is then filled in by the vendor, in this instance the recorded owner and the form is given to the purchaser, or the newly recorded owner, who completes the portion of the form devoted to reassignment and sees that the operating agency does likewise. Where the operating agency and the recorded owner are the same, this portion of the form need only be signed and dated

Owners Newly Defined

When the record, transfer and reassignment form is completely filled out, it is forwarded by the purchaser to the Department of Commerce, or it may be placed in the hands of one of the authorized representatives When this is received, a new card for the plane and a new form, giving the name of the purchaser, will be issued by the Department, but until this is received, the plane cannot be operated

Under the new system the recorded owner of a plane is defined as being the individual, company or corporation, which has presented evidence of its legal title to the plane, which is acceptable to the Department The operating agency is defined as the individual, company or corporation which is in possession of the aircraft and is entitled to control its operations

The application forms for registration have been changed and now include spaces for giving additional information required by the Department as a result of the new system This includes a supplement to be filled in by the operating agency showing the citizenship of the plane The other forms are being printed and the mechanical devices necessary for the multiple copying which the method entails, are being installed in Washington, the Chamber of Commerce statement says

Sanction Given Four Big Races

WASHINGTON, D C—The National Air Races for this year, to be held at Cleveland August 24 to September 2, is outstanding among the four competitive events which have been sanctioned by the National Aeronautics Association. The staging of the races at Cleveland is dependent upon the raising in that city of $100 000 for prize money The other three events are the National Balloon Race at Pittsburgh, May 4, the Gardner Cup Race at St Louis, May 28 29 and 30, and the Gordon Bennett International Balloon Race at St. Louis, October 1.

Purchase of Supply Concerns Negotiated

COLLEGE POINT, L I—Negotiations for the purchase of the Standard Automatic Products Co of Corry, Pa., and the Johnson Airplane & Supply Co. and National Steel Products Co., both of Dayton, O., have been completed tentatively by the Aero Supply Manufacturing Co., it is reported

The consummation of these negotiations expected to be completed some time this month, would bring together under the direction of the local concern a wide range of aeronautical accessories The interests involved are reported to anticipate no obstacles in the merger plans

The local concern was organized in New York City seven years ago

Open Martin Unit

BALTIMORE, MD—A force of some 250 employes brought from Cleveland are now at work in the new Glenn L. Martin Co experimental factory here on aircraft designs for the Navy Regular production, it is said, will not commence until the completion of the main plant which is expected to be ready within four months

First Pittsburgh Show Committee Announced

PITTSBURGH, PA—Virtually every phase of aviation in the tri-state region is represented in the group of men selected to comprise the show committee of the First Annual Pittsburgh Aircraft Show, to be held March 9 to 16, inclusive at Motor Square Garden Baum Boulevard and Beatty Street, under auspices of the Aero Club of Pittsburgh

Members of the show committee, as announced by Raymond A Tucker, its chairman include representatives of virtually every airport, aircraft operator, airplane manufacturer, and aircraft accessory manufacturer in the Pittsburgh district Other organizations represented are the Pittsburgh Chamber of Commerce, the Cleveland air mail line, the Pennsylvania National Guard the Aero Club of Penn Commission and the Pittsburgh City County Air Board

Headquarters for the aircraft show have been established in the lobby of the William Penn Hotel with Ray Krimm show director in charge William J Austin, a pilot at Rodgers Field has been appointed sales manager for the Pittsburgh exposition.

Consolidated Merges With Two Companies

NEW YORK N Y—Consolidated Instrument Company of America has acquired control of Julien P. Friez & Sons of Baltimore, manufacturer of meteorological instruments and the Moulded Insulation Co. of Mount Vernon, N Y., maker of Bakelite parts for precision and meteorological instruments.

The merger, one of the largest in the airplane accessory field to date, makes the Consolidated concern one of the largest distributors of aviation instruments in the country It will handle the entire output of the acquired plants Negotiations for the acquisition of a third concern are reported to be under way

Will Test Supercharger

HARTFORD CONN—Tests are to be conducted shortly on a special supercharger developed by the Pratt & Whitney engineers it is announced here The device is expected to enable a Wasp engine to give sea level horsepower at 20 000 ft. altitude A Vought Corsair O2U-2 has been loaned by the Navy for the experimental flights

Schneider Date Announced

NEW YORK N Y—Information has been received here that the Schneider Cup Race is to be held on September 6-7 over the Solent, near Cowes, England. The United States plane, it is said, will be powered by a Packard X 24 cylinder engine

Universal Buys Continental Line

Say New Acquisition Will Form First Unit of Southern Route

NEW YORK N Y—Purchase by his company of Continental Airlines, Inc., operator of the air mail line from Cleveland to Louisville for an unreported sum has just been announced by Louis H. Piper president of Universal Aviation Corp.

Acquisition of the Continental line has added an extremely important link to the large system controlled by the Universal corporation, according to the announcement, in that it gives the company a route through one of the largest industrial centers of the country In addition it is said that the Continental lines will form the first unit of the proposed Southern Cross continental air mail line, which the Post Office Department is planning for Cleveland, Louisville, Nashville, Memphis, Dallas, El Paso and the Pacific Coast

"Importance is attached to the purchase of Continental Airlines by Universal because of the increasing interest in a southern air mail and passenger route across the United States, where the weather is less severe and of shorter duration and schedules are more easily maintained than in the north" the announcement says. "Whatever the rest of the routing may be the Cleveland and Louisville route will be the first step, and it presents the possibility of tremendous poundage of air mail and larger passenger revenue because of the territory covered."

Auxiliary Features Planned

The cities on the route covered by Continental Airlines are Cleveland, Akron Columbus, Dayton, Cincinnati and Louisville In accord with the policy of the Universal corporation, both passengers and air mail will be carried over the route Fokker planes of the type ordered for use on the other routes of the Universal system will be used on the new unit Besides the passenger and mail service, the company plans auxiliary features, such as photography schools and taxi service

Announce New Swift Models

WICHITA, KAN—Production in the near future on a two place sport biplane built around the Warner Scarab engine is announced by the Swift Aircraft Co of this city A special OX-5 training plane is also to be manufactured

Excelsior Plans Monoplane

WICHITA KAN—The Excelsior-Henderson Cycle Company of Wichita announces a low wing semi-cantilever monoplane to be turned out here during 1929

Keep Fragments Of Wright Plane

PITTSFIELD, MASS—Fragments of the second successful plane built by the Wright brothers, called the first plane to go 10 mi. in a single flight, are lying in the basement of the Museum of Natural History and Arts here, awaiting the attention of the one man, Orville Wright, who can restore them to the semblance of the original frail craft

For 20 yr., or since the wreckage of the plane was collected at Kitty Hawk Beach and sent to Pittsfield, influential men of the city have been eager to have Orville Wright direct this work.

W. A. E. Reorganizes To Get More Capital

LOS ANGELES, CALIF—Formal announcement of reorganization of Western Air Express, Inc, under Delaware laws to provided for a larger capitalization and for the division of shares into smaller units has been made by Harris M Hanshoe, president

A new corporation has been formed known as Western Air Express Corp with an authorized capitalization of $5 000 000 divided into 500 000 shares of $10 par value Directors have authorized the issuance of 25 shares of the new capital stock issue for each share of the old stock, provided a majority of stockholders of the old company consent to the transfer

Directors and officers named for the new corporation are said to be only temporary and it is intimated that they will be replaced by those of the present Western Air Express, Inc., following completion of the exchange of shares

Will Build I. F. Engines

NEW YORK, N Y—The Italian Isotta-Fraschini aircraft engine is to be manufactured in this country, it is reported by the group headed by Enea Bossi of the American Aeronautical Corp. which has also undertaken to build the Savoia-Marchetti seaplanes in this country The engines range from six-in-line air cooled type developing 80 hp to the powerful water cooled type which in tests has developed 1,200 hp These engines are widely used in Italian planes and have been installed in many German machines

Name Skyways Moth Agent

LOWELL MASS—Skyways Inc of Boston, Portland Lawrence and Wareham has been named as the first distributor for the American made D H Moth planes being produced here by the Moth Aircraft Corp The first plane will be used as a factory demonstrator while the second and third will go to Skyways

Many Fliers at Miami Air Meet

Big Dedication Reaches Climax In Opening of Pan American Services

MIAMI FLA—Dedication of the Miami Municipal Airport last week was marked by the greatest aerial activity this city has known Nearly 100 planes both military and commercial competed in the All-American Air Meet Exposition held the first two days of the official opening, and on the third day Pan American Airways formally inaugurated its passenger and mail service to the Bahamas and the extended service to the West Indies

Well over 100 pilots had responded to the invitations sent out asking them to participate in the event, but on the first day there were less than 50 commercial and 20 military planes at the field. The others had been delayed by the bad weather However, the weather cleared, and on the second day, from 30 to 40 more fliers arrived This group was headed by Brock and Schlee, who flew in with their Lockheed "Vega" monoplane

Many Races Held

The air meet was opened both days with an aerial parade over the city, in which both the military and commercial planes participated, and on both days it was followed immediately by various events at the field These events included races for planes with engines of 50 hp or less, those powered with engines up to the OX-5 class and those powered with engines of 200 hp or less races for cabin and open cockpit planes, races for the Army and Navy machines, balloon bursting contests, dead stick landing contests, and the selection of the plane presenting the neatest appearance Cash prizes and trophies were presented the winners in each event

The second day of the meet, Pan American Airways conducted a rehearsal of its service from Miami to Nassau in the Bahamas The run between the two cities is 188 mi and is normally made in two hours but on this occasion Harry Rogers piloted one of the "Wasp" powered, Sikorsky "Amphibions" over the route in 1 hr, 50 min each way This was the first flight made with passengers. It is interesting to note that the only competition the line will have at present is that offered by an 18 hr steamer service

New Lines Opened

The dedication of the Miami Airport was culminated the morning of the third day with the formal inauguration of the Nassau line and the new 1,400 mi system that includes stops at the principal cities in the countries of the West Indian group. The ceremonies were attended by many notables from the island nations as well as a number of prominent United States government and aviation officials.

Personnel

ALLEN W MORTON, who has been connected with the American Hammered Piston Ring Co, Baltimore, Md, for 10 yr, has been named president and general manager of that concern. W C. Stettinius has resigned from that position but will remain on the board of directors as vice chairman.

A. T LEBLANC has joined the aircraft division, manufacturers sales department of the Robert Bosch Magneto Co, Inc., Long Island City, N. Y.

JAMES A BOWERS has been named assistant chief engineer of the Consolidated Instrument Company of America, Inc., New York City.

HERBERT HOOVER, JR., son of the president-elect, has accepted a position with Western Air Express as head of the radio department. His title will be assistant to Harris M Hanshue, president of the firm, and he will have charge of radio telephone installation on W. A E. passenger planes

J G NALL of San Francisco and R. G HAZEN of Dallas, inspectors, have been added to the staff of the Southern California Branch U S Department of Commerce Aviation Division, Los Angeles

CAPT. ARCHIBALD B JOHNSON, who is well known for his war time service and his activities in commercial aviation since then, has been appointed sales manager of the Moth Aircraft Corp, it has just been announced. WILLIAM R. OSTERTAG graduate of the U. S. Naval Academy of the class of 1924 and graduate of the U S Marine Corps Reserve training course, has joined the sales staff of the company it is announced also Headquarters of the aircraft company are maintained in the Graybar Building, New York

F. L. BARCHARD, builder and owner of the Pal-Waukee Airport near Chicago, Ill., and formerly the Swallow dealer in the Chicago district, has become sales manager for the Swallow Airplane Manufacturing Co, one of the oldest and best known aircraft manufacturers in the country

COL. HALSEY DUNWOODIE, vice president of Gardner Motor Car Co and executive vice president of Universal Aviation Corp., COL. CEDRIC FAUNTLEROY, New York banker, and WALTER W HEAD Omaha financier, were recently elected directors of Universal Air Lines System, according to an announcement made by L H. Piper president of the Universal organization

JAMES COOPER and KENNETH RODGERS former students of the Rankin aviation school, Portland, Ore are taking over the ground school instruction at the Eyerly Aeronautical School, Salem, Ore. it has been learned A new class room and office building have been erected at the school, which was operated formerly under the name of Pacific Airplane Service, and night classes are now a regular feature W A. Hazelwood is the chief pilot.

ARTHUR SNOWDEN, who has been a member of the New York sales force of Detroit Steel Products Co, manufacturer of hangar doors and steel window frames, has been promoted to the position of aviation sales director, according to an announcement made by officials of the firm. Mr Snowden is an experienced pilot and was formerly engineering officer at Miller Field Staten Island N Y

GEORGE PARKER of Berkeley, Calif., has joined the staff of Metro Air Service according to an announcement by Lieut. Franklin Rose. The Metro organization is operating at the Oakland Municipal Airport

CAPT IENAR ELM, former Army pilot, has joined with MAJ LIVINGSTON IRVING and will conduct the ground school classes offered by the Irving and Rhodes Flying Service, according to a recent announcement This service operates from the Oakland Municipal Airport, Oakland, Calif

R D. ELLIS, formerly airport manager at the Robbinsdale Airport near Minneapolis, and R W JACKSON, former automobile dealer of the same city, have joined the sales staff of the Mohawk Aircraft Corp

MARK M MCCOMB, formerly with the Hamilton Metalplane Co of Milwaukee has been named field representative for the Mohawk company Mr McComb will have complete charge of dealers organizations in the Wisconsin territory He will establish headquarters in Milwaukee

ROGER SCHUPP former secretary for the Louisville, Ky, Board of Park Commissioners and more recently acting secretary of the Louisville and Jefferson County Air Board, was elected the secretary of the air board at its last meeting it has been learned.

A J EDWARDS formerly of the Ryan Aircraft, Corp, has become the general manager of the Swift Aircraft Corp, Wichita Kan., according to a report.

Trade Tips

It Has Been Reported That—

—The city commissioners of Amarillo, Tex., are taking bids on construction of a hangar at the local airport

—A. Gilhaus, 36th Street, Hialeah, Fla, is taking bids for erection of a hangar for Pan American Airways, Inc

—Construction of an assembly shed, one story, 40 by 60 ft, at 320 West Front Street is planned by the Boeing company, Georgetown Station, Seattle Wash

—Contract for hangars at the Seattle airport is soon to be let by the King County Commissioners Improvements to cost about $150 000 are planned

—The Arkansas Airplane Cotton Dusting Co, Inc., of Pine Bluff, Ark, will erect a hangar to accommodate 12 planes and a machine shop equipped for full aircraft repair work. Operation of eight planes is planned.

—C R Wassell, 1221 South Grand Boulevard, St. Louis, Mo, of the Missouri National Guard, will soon let the contract for construction of an 80 by 100 ft and a 100 by 100 ft hangar and also an 85 by 125 ft administration building at the Lambert St Louis Flying Field The cost is put at about $80 000

—State Aviation Commissioner Knox of Connecticut stated in his first report to Gov John H. Trumbull that "the effectiveness of the state aviation department in maintaining proper control of planes will dwindle to practically zero" without additional equipment in the form of a state-owned airplane

—A company may be formed by the citizens of Greenville, Pa, for the purpose of constructing a $50,000 airport there. If the plan is carried out, approximately $20,000 will be spent in the purchase of land, while $30,000 will be used in buying equipment as it is needed F A Conner, president of the Chamber of Commerce is the author of the plan to form the organization

Approved Airplanes Total 95

WASHINGTON, D. C—With certificates lately granted to 12 new models, the total of approved type airplanes now reaches 95 according to the Aeronautics Branch Approved planes, 84 through 95, are as follows:

No 84—Consolidated Model 14, two place open land biplane, Scarab engine; No. 85—Hamilton H-45 eight place closed land monoplane, Wasp engine; No 86—Laird LC-B, three place open land biplane, Whirlwind; No 87—Ford 4-AT, 14 place closed land monoplane, three Whirlwinds; No 88—Kreider-Reisner C-4, three place open land biplane, Comet; No 89—Fairchild 71, seven place closed convertible land or sea monoplane Wasp; No 90—Loening C2-C, six place closed amphibian biplane, Cyclone; No. 91—Loening C2-H, six place closed amphibian biplane, Hornet No 92—Pitcairn PA-6 single place open land biplane Whirlwind; No 93—Lockheed Vega, five place closed land monoplane, Wasp—No 94—Hamilton H-47, eight place closed land monoplane Hornet, and No 95—Mohawk Pinto two place open land monoplane, Velie M-5

AIRPORTS AND AIRLINES

Newark-Atlantic City Air Service Planned

LAKEHURST, N J—Inauguration of a passenger service, ultimately operating on an hourly schedule, between Newark and Atlantic City with Lakehurst as an intermediate stop is planned by Great Eastern Airways, Inc William H Mallon Co, Inc, Asbury Park engineering firm, will build the Lakehurst Airport

A two hour schedule is to be maintained at first, but it is planned to place five cabin planes in service on the new line, which will permit the institution of the hourly schedule during the day No night service is planned The airline distance from Newark to Atlantic City is 120 mi With the intermediate stops the run will be made in an hour and one half The fare charged, it is said, will be based on a rate of about 20c a mile.

Great Eastern Airways, Inc., which was recently organized, is incorporated under the laws of the State of Delaware with a capitalization of $100 000 In addition to the operation of the airline, the firm is taking over the operation of the Lakehurst Airport. A new hangar measuring 60 x 80 ft is to be erected, and overhaul and repair shops will be maintained there The company plans also to inaugurate a taxi and photographic service

Installation Reported Of 250 "Aerovanes"

NEW YORK N Y—Within the last four months 250 "Aerovanes" have been erected in New York, New Jersey, Pennsylvania and North Carolina, it has just been announced by E. C. Learock, sales manager for Aerovane Utilities Corp manufacturer of the Aerovane marker

The company is adding other models to its line, and contemplates the erection of at least 5,000 more markers this year The new models are of all-steel construction and carry town marking arrows from 30 to 100 ft in length bearing letters of from six to 15 ft. in height Some of these will be illuminated

The sales force of the firm it is declared, will be functioning nationally by February Special manuals regarding the Aerovane are being completed for sales work

May Lease Buffalo Sites

BUFFALO N Y—Corporation Council Gregory U Harmon has ruled that land may be leased by the city to private corporations wishing to construct hangars or other buildings at the Buffalo airport Hangars and other structures are requested at the Buffalo airport by the Gray Goose Lines of Chicago Airport Director N E Duffy states.

Mails at Newark Soon

NEWARK, N J—Air mail will be handled at the metropolitan airport here instead of at Hadley Field the old terminal, beginning some time during the first 10 days of February, it was announced recently by Assistant Postmaster General Glover Insufficient lighting facilities and runways have delayed opening the new field. The companies to operate from here are the Colonial planes to Boston and Montreal, National Air Transport to Chicago and Pitcairn Aviation to Atlanta and Miami James W Costello, city chief engineer, is supervising the improvements

Boeing Firm Reports Traffic and Mileage

SAN FRANCISCO, CALIF—Boeing services, it is reported completed a total of 3,335 973 mi of flying as the year closed Boeing Air Transport, inaugurated July 1, 1927, and Pacific Air Transport which came under the Boeing system Jan 1, 1928, accrued this mileage while transporting 1,413 596 lb of mail.

Passengers totaling 3 907 were carried over 2 143,777 passenger miles Several tons of air express were transported under contract with the American Railway Express Co W G Herron, vice president in charge of traffic issued the report and said that he expects an enormous increase during the present year

Totals for 1928 on Boeing Air Transport, San Francisco & Oakland-Chicago route are: miles flown 2,178,365, mail carried, 986,279 lb, passengers carried, 1863, passenger miles flown, 1 279 778. Totals for 1928 on Pacific Air Transport, Seattle-Los Angeles are miles flown, 703 542 mail carried, 137,972 lb; passengers carried, 1484, passenger miles flown, 506 509

Winter Activity at Duluth

DULUTH, MINN—The Great Lakes Airways will carry on activity during the remainder of the winter from Lake Superior and St Louis Bay, which have frozen solid enough to be used with safety R J Sergent, the chief pilot, has mentioned that skis will be ready to use as soon as there is too much snow to operate with wheels

Sikorsky Cruise Ends

JACKSONVILLE, FLA—The cruise of J M Patterson's "Amphibion" Liberty ended here January 10 having concluded a long trip through the Carribean. Lieut Frederick H Becker piloted the plane, which took off from Miami on December 7

December Mails Show New Gains

Surpass November and October Marks as Total Goes to 537,113 Lb.

WASHINGTON, D. C.—During December, 1928, the United States air mail services carried 537,113 lb of mail as compared with 165 768 lb during December 1927, and 39,350 lb for that month in 1926, according to figures made public by postal authorities The increase in December, 1928, over November, 1928, amounted to 112 648 lb, or 26 5 per cent An increase of 69,691 lb. over the October total was also noted

Some 30,544 mi of flying is scheduled daily over the 22 mail routes now in operation. Poundage figures according to run, November total, and December total, respectively, follow:

Boston-New York, 6,993, 8,344, Chicago-St. Louis, 6 923, 7,185, Chicago-Dallas, 25,760, 29,813, Salt Lake-Los Angeles, 43 066, 65,624, Salt Lake Pasco, 16,544, 20,238, Seattle Los Angeles, 15,467, 20 267, Chicago-Minneapolis, 8,875, 14,003, Cleveland Pittsburgh, 12,126, 11,962, Cheyenne-Pueblo, 6,766, 9,099, Cleveland Louisville, 6,248, 6,262, New York-Chicago, 105,293, 126 179, Chicago-San Francisco, 112,187, 142 897, New York-Atlanta, 16,688, 20,906, Albany Cleveland, 10,225, 7,679, Dallas Galveston, 3,267, 3,846, Dallas-Laredo, 5,614, 6,736, Atlanta New Orleans, 4 096, 4,352, Chicago-Cincinnati, 4 910, 5,286, Atlanta-Miami, 0, 5,841 (newly opened), Great Falls-Salt Lake, 4,165, 5 121, Chicago-Bay City, 8 829, 8,694, and Chicago Atlanta, 1,076, 7,779

It may be noted that increases over November were shown on every route but three—the Cleveland Pittsburgh Albany-Cleveland, and Chicago-Bay City runs

Plan Greenville Field Firm

GREENVILLE, PA—Plans for the formation of a $50 000 company, for the purpose of building and operating an airport here, were outlined by F A. Conner, president of the local chamber of commerce at a recent meeting held in the Penn High School According to the plan $20 000 in common stock would be issued to provide for the purchase of the land, while the remaining $30,000 in stock would be sold to raise money needed for the development of the field Unless the common stock is subscribed by April 1, however, the plan probably will be abandoned, Mr Conner told the prospective backers.

Bid on Air Mail Line to Mexico

To Award 10 yr. Contract for Brownsville-Vera Cruz Service

WASHINGTON, D C—Announcement has been made that the office of the Second Assistant Postmaster General will receive sealed bids until 12 Noon, January 26 for the carrying of United States mail under a 10 yr contract over the proposed air mail route from Brownsville, Tex, to Vera Cruz, Mexico The service is to be inaugurated not later than six months after the award of the contract

While it is understood that the international exchange point will be shifted from Laredo, Tex, to Brownsville, and that the route from New Orleans to Houston may be extended to that city, the Post Office Department is reserving the right to designate any other point in Texas as the Northern terminus of the line. Vera Cruz has not been definitely established as the southern terminus either

Terminal Undetermined

The line may terminate at Vera Cruz, Mexico City, or "such other points in Mexico as may be acceptable to the Mexican Government," the announcement says In addition, the Postmaster General is reserving the right to extend the route by way of Vera Cruz, Puerto Mexico and Tuxtla Gutierrez to any of the Central American countries if it should be desired later on. Stops will be made in those countries at points acceptable to the individual governments

The proposed service to Mexico will be maintained over the shortest practicable airway for land planes one way, seven times a week The maximum load which will be required, will not exceed 800 lb per trip In submitting proposals, the bidders must send in statements showing to the satisfaction of the Postmaster General that they can meet the requirements of the Mexican Government concerning the transport of mails by air to Mexico The bidders must also state the rate per mile of outbound flights on the route and the approximate mileage, subject to a correction of 500 mi A bond of $25 000 will be required with each bid

Facilities Not Provided

The contractor must maintain his own arrangements for landing fields, lighting equipment, radio stations and any other aids that may be necessary for the proper maintenance of the service, the announcement provides No compensation will be granted for any trips that are not made, although on a partially completed trip, pro rata pay will be allowed for the airline distance if there is no delay in the mails over the ordinary railroad or ship service Instructions to bidders, blank forms for the proposal and accompanying bond may be obtained from the Second Assistant Postmaster General, Division of International Postal Service, Washington

Oregon's Bonds Declared Valid

SALEM, ORE.—Oregon cities which have voted bonds for the establishment of municipal airports are within their rights, according to a decision of the state supreme court The opinion holds an airport, owned by a city and open to the use of all airplanes as a community, is for the benefit of the city as a community and not to any individuals. Legality of a $50 000 bond issue in Salem and $25,000 in Roseburg for airports had been challenged

New Flagging System At Los Angeles Field

LOS ANGELES, CALIF—A new flagging system has been inaugurated at the Los Angeles field of the Aero Corporation of Calif in order that plane traffic in and out of the field may be effectively controlled from the ground

Display of a red flag forbids landings, white flag signifies that the field is clear, and if a green flag is displayed it means the party signalled is to land at once Flags are controlled by a field attendant who is permanently stationed at the head of the runway where he controls signals and does all checking of planes in and out of the field

Braniff Plans New Line

OKLAHOMA CITY, OKLA.—Paul R Braniff, operating the Braniff Air Lines, has announced his intention of opening a passenger line between this city and Dallas, Tex Fokker monoplanes, it is said are to be used in the service, which is to start on delivery of the planes. Mr Braniff recently added a new Travel Air six passenger plane to the Oklahoma-Tulsa line and has placed orders for two more to be used on the same route The company furthermore contemplates a flying school here

Knoll Plane to Make Tour

WICHITA, KAN—The six place Knoll plane recently completed and successfully tested, shortly is to be taken on a tour of the country by Howard Jones chief test pilot of the company, it is announced Capt Richard Duncan, newly associated with the firm as representative, will accompany Jones

Record Field Revenue Announced at Oakland

OAKLAND, CALIF — Ten times greater revenue accrued to the city for the operation of the Oakland municipal field during the month of December, 1928, than was received for the same period in the previous year, according to the board of port commissioners' report.

The gross revenue last month totalled $4,571 30, it is said, while revenue in December, 1927, was but $456. The month's revenue also represented a new record for the field since the greatest amount previous received was $4 004 16, the October gross.

New commercial operators at the airport and a greater number of visiting planes are responsible for the increased revenue, it was said. Passengers and students carried at the airport tripled in number during December, as compared with the same month of 1927 Last month 2,203 passengers were carried and 428 student flights were made During December, 1927, 790 passengers and students were carried.

Plane landings recorded at the airport in December totaled 3 961, while the figure for December, 1927, was 2 056 During the year 1928, 66 432 plane landings were recorded at Oakland municipal airport, 40 691 passengers were carried 8 297 student flights were made and the gross revenue totaled $30 794,34. Transient plane landings at the airport during the year totaled 3,443 Passengers carried in transient planes totaled 4 732

Buffalo Airport Will Have Improvement

BUFFALO, N Y—The common council has voted to expend between $400,000 and $500 000 to make Buffalo's airport one of the best in the country Bids were asked immediately for the erection of two hangars, the construction of five more runways the installation of a railway switch, the grading and seeding of the airport area to put the entire port in flying condition, additional office space, and the construction of a control tower atop the administration building in order to super vise air traffic fully both day and night.

Allotment of hangar space for from two to five airplanes was made to the United States Army Air Corps Reserve at the yearly rental of $1 Bids were to be opened January 18 It is expected all improvements will be made by summer

Airports Planned by 14 Cities

WASHINGTON, D C—Fourteen more cities have announced plans for municipal airports, according to the Aeronautics Branch They are Montgomery, Ala , Newhall, Calif Gainesville, Fla , Melbourne, Fla., Jay, N Y , Ada, Okla , Pawnee, Okla , Erie, Pa., Denton, Tex , Saint Jo Tex Buena Vista, Va , Chilhowie, Va., Pullman Wash and Shelton, Wash

Air Station Kite Wires a Menace

WASHINGTON, D C.—A special warning to pilots of the danger existing in the vicinity of the Upper Air Stations as a result of the piano wire holding the captive balloons and kites used in making daily observations, has been issued by the Aeronautics Branch, Department of Commerce.

The kites and balloons at times reach altitudes well over 10 000 ft., and have been sent up as high as four and one-half miles In clear weather, they are clearly discernible, but are usually hidden from view in cloudy weather However, the wire is extremely difficult to see from any great distance. Pilots are warned to keep a sharp lookout when operating within a 10 mi. radius of the stations at Broken Arrow, Okla , Due West, S C ; Ellendale, N D , Groesbeck, Tex., and Royal Center, Ind.

Army's Clover Field Station to Long Beach

LONG BEACH, CALIF—Recommendation of the Commanding General, Ninth Corps Area, to move the air corps reserve activities from Clover Field Santa Monica to this city has been approved by the War Department Long Beach has offered the use of a strip of ground 150 by 450 ft on the new airport for the erection of hangars and other necessary buildings and has also agreed to move the air corps structures from Clover Field

In addition, the city will erect suitable buildings for use as a headquarters and flight surgeon's office together with a club building for transient officers The move is to be made sometime prior to July 1

Air Board for Duluth

DULUTH MINN—The local chamber of commerce has announced through its president, Donald S Holmes, that an air board has been appointed The 11 men chosen will work under the direction of C. E. Foster, a consulting engineer, who has been selected chairman and all are to serve without pay for the best interests of the city The problem is to hasten the selection, acquisition, and development of a site suitable for a municipal airport

Newark is Entry Point

NEWARK N J—The metropolitan airport here has been designated by the Treasury Department as an airport of entry in the New York district

Colonial Makes Mail Record

NEW YORK, N Y—A new air mail record was established by Colonial Air Transport for the month of December when 8 312 lb of mail were carried over the New York-Boston run. This is an increase of 820 lb over the previous record for the line made in October and an increase of 1,329 lb over November The line carried 1,999 lb of mail during December, 1927, and 1,057 lb in the same month of 1926.

To Increase Weather Information at Buffalo

BUFFALO, N Y—Word received here by James H Spencer, meteorologist of the Buffalo Weather Bureau, stated that there will be an improvement of the weather report service at the Buffalo airport and along the Cleveland-Albany airmail route Officials of the weather bureau of the Department of Commerce at Washington will arrive here about the middle of January for the purpose of arranging an extension of the weather report service

Establishment of branch stations at Dunkirk, under Mr Spencer's jurisdiction, and one at Ashtabula, under the Cleveland meteorologist office are contemplated

The Buffalo airport at the present time is receiving special weather reports from Albany, Little Falls, Syracuse, Rochester, Erie and Cleveland besides numerous reports at 8.00 A M daily, covering all routes out of Buffalo. Zone forecasts are also furnished, covering the lake region and North Atlantic states

Stamped Government Envelope is Available

WASHINGTON, D C—Known as the Government No 13 a new air mail stamped envelope has been brought out The borders of the envelope are encircled with red white and blue parallelograms The special embossed stamp impression on this new piece is circular in shape and shows a monoplane in flight outlined in white and printed in blue ink with the words "U S Postage—Via Air Mail" encircling the border A large numberal 5c appears in white in a field of blue directly beneath the plane.

This envelope is issued to meet the ever-increasing demand for air mail dispatches and it is estimated that approximately 100 000 000 will be issued during the present calendar year Postmasters have been instructed to receive orders, and they will be printed and delivered as fast as production will permit. This envelope will also be available in a No. 5 and 8 size at an early date

Palm Beach Airport Now Open

WEST PALM BEACH, FLA.—Palm Beach Airport is now open, it has just been announced by Waldo E Thompson, manager of Palm Beach Flying Service

Announces Air Customs Rules

Regulations of United States Will Go into Effect On February 1

WASHINGTON, D C.—Supervision of entry of merchandise into this country by air will take its place beside that of shipments by water and land when the Customs Bureau of the Treasury Department puts into effect February 1 the first aircraft customs regulations promulgated in this country

It is provided that aircraft arriving from a foreign country must make the first landing only at an official airport of entry, except in case of a forced landing or unless special permission is obtained from the commissioner of customs The person in charge of the plane shall report his arrival immediately to the customs officer and shall produce a manifest, signed under oath by him and certified by the person in charge at the airport of departure, describing the baggage or freight carried or the nature of repairs done to the plane while in a foreign country, in the case of an American plane The plane must not depart after the landing or discharge its cargo without permission of the customs officer

Rule on Forced Landings

In case of a forced landing, the person in charge is not allowed to remove any baggage or merchandise or allow any passengers to leave the plane, except for the sake of safety or preservation, until a customs officer has been notified and permission obtained from him Mail may be removed at once but must be delivered directly to a responsible postal employee

If the plane is able to proceed after repairs or servicing it should be flown to the original destination and a full report of the incident made If it is impossible to proceed the report should be made as soon as possible to the nearest customs authority If the person in charge is disabled the owner of the aircraft, mechanic or other employee must make the report.

The flight of a plane from a foreign point to an airport of entry on a trip that is not scheduled must be reported to the customs officials at the destination before the flight stars and in time to allow the officials to meet the plane The markings on the plane and the name of the person in charge charge must be included in this information to assist in the identification of the plane when it arrives

Vehicle Laws Apply

The second administrative provisions of the customs laws applicable to vehicles arriving from contiguous foreign territory shall apply to aircraft and the baggage, merchandise and passengers carried therein Administrative laws applicable solely to vessels, however do not apply

FOREIGN ACTIVITIES

New Plane Built By Hawker Firm

Jupiter Powered Craft Has Metal Wings and Fuselage Frames

KINGSTON ON THAMES, ENGLAND—The Hawker "Hawfinch" is a biplane with an all metal frame embodying the type of construction devised by the Hawker Engineering Co, Ltd, of this city The general lay-out of the machine is conventional though the form of cowling used on the Bristol Jupiter air cooled radial engine, which leaves only the extreme cylinder heads exposed, is worthy of note Either the Bristol Jupiter Series VI air cooled engine of 480 hp or the Series VII supercharged engine of the same make may be fitted

The "Hawfinch" has a span of 33 ft 6 in., length of 24 ft. 4 in., and has 295 sq. ft. wing surface. The empty weight stripped is 1,835 lb The total load is 900 lb., giving a loaded weight of 2,735 lb., a wing loading of 9.3 lb per sq ft., and a power loading of 5.8 lb per hp

High Service Ceiling

With the unsupercharged engine the machine climbs to 3,000 m. (9,840 ft.) in 5½ min and to 6,000 m. (19,680 ft.) in 16 min and attains a speed of 159 m.p.h. at 9,840 ft, 149 m.p.h. at 19,680 ft. and has a service ceiling of 27,000 ft. With the supercharged engine 9,840 ft. is reached in 4.7 min., 19,680 ft in 11.8 min., with speeds of 171 m.p.h and 165 m.p.h at these heights. The service ceiling is then 30,000 ft

The "Hawfinch" may be equipped with a twin float seaplane undercarriage employing duralumin "Vee" bottomed floats, and stainless steel undercarriage fittings. This adds about 300 lb to the weight and naturally reduces both climb and speed The machine will nevertheless reach 153 m.p.h. unsupercharged and 165 m.p.h supercharged at 9,840 ft. and climb to 19,680 ft in 20 and in 13.2 min respectively.

Uses Ball-Ended Struts

The fuselage is constructed of steel tubing Longerons are solid drawn circular tubes which are flattened by a rolling process at every strut joint The two side frames each form an independently assembled unit tubular struts also with flattened ends being attached to the longerons by flat steel fitch plates. These plates are secured to the longerons by a single bolt with a cup head The side struts are riveted to the fitch plates The two side frames are assembled to form the complete frame with ball-ended struts, which fit into the cup head bolts, and wire cross-bracing The whole frame is a simple production job, which can be dissembled and packed as two flat girders for transport.

The wings are built on spars of solid drawn tubes, rolled to what is known as the "double eight" section. Though this type of spar is slightly heavier than certain other types of metal spar, it is cheap presents no difficulties in regard to the attachment of fittings, and is remarkably robust. Drag struts are of steel and ribs of aluminum alloy

The undercarriage, of the cross axle type, has rubber in compression plus an oil dashpot and provides a very long travel

Military equipment comprises the usual two 303 calibre machine guns with Constantinesco synchronizing gear, 1,200 rounds of ammunition, oxygen-apparatus, sending and receiving short wave wireless, and a full equipment of flying and engine instruments The fuel capacity is 54 Imperial (65 U. S gal)

European Fares Reduced

BERLIN GERMANY,—A reduction of about 10 per cent in round trip fares on airlines in 11 European countries, making the price by plane less than for first class passage on international express trains, has been approved at a recent conference of operating companies at Berlin The change was based on the results of last year's business.

Hinkler Gets Medal

LONDON, ENGLAND—Bert Hinkler, British pilot who flew from England to Australia, 16,000 mi, last year in an Avro Avian in 15½ days, has been awarded the 1928 gold medal of the Federation Aeronautique Internationale and the Royal Air Force Cross in recognition of his feat

Bleriot Building Flying Boat

PARIS, FRANCE—It is reported that Bleriot works are now building a transocean flying boat with a span of 91 ft., an overall length of 52 ft, equipped with four engines developing a total of 3,200 hp and capable of carrying 30 passengers A flight across the Atlantic is planed after a series of tests in the spring over Asia and Africa under supervision of Bleriot's son

Would Circle Continent

MEXICO CITY MEXICO—A flight around South America, including the first rounding of Cape Horn by an airplane, is proposed by Lieut Col Roberto Fierro Mexican pilot who has made a non-stop flight from Lower California to this city and later a good will tour to Havana and Central American republics He expects to start as soon as funds for the project have been received.

Peruvian Fliers Halted

NATAL, BRAZIL—As we go to press the Peru to New York fliers, Carlos Martinez de Pinillos and Naval Lieut Carlos Zegarra, are here waiting for further information about landing conditions at Belem their next objective, before continuing their flight. They took off from Lima, Peru, December 11 and had hoped to reach New York City by January 15

To Open Canada Mail Line

SAINT JOHN, NEW BRUNSWICK—Air mail service between Ottawa, Montreal, Saint John and Halifax will be opened on January 28 according to Hon P J Veniot, postmaster general Daily Ottawa Montreal and Saint John-Halifax service is planned with the Montreal-Saint John link bi weekly initially

The Bristol [illegible] "Hawfinch"

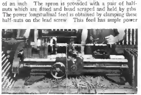
THE BUYER'S LOG BOOK

South Bend Lathe

ONE OF the most recent additions to the products manufactured by the South Bend Lathe Works, 404 East Madison St, South Bend, Ind., is the Nine Inch Junior Back Geared Screw Cutting Precision Lathe This machine is made in five lengths of bed and is available in bench or floor leg models with counter shaft drive or any one of four styles of motor drive Mechanical parts of all models are identical This lathe may be used in machining all kinds of metal and in working wood, hard rubber, fibre and other composition materials

The semi steel lathe bed is a heavy gray iron casting containing about 18 per cent steel. Beds are rough planed, then seasoned for a period of four to six weeks and then finished planed and hand scraped to insure accuracy. The headstock is back geared and the three step cone permits six spindle speeds All gears are covered with guards. A quick acting bull gear clamp permits changing from direct cone drive to back geared drive or vice versa without the use of a wrench The headstock spindle is made of special quality carbon spindle steel and is finished ground all over. It has a ¾ in hole which permits rods, bars and tubing to be passed through it and held in a lathe chuck or draw in collet chuck for machining Phosphor bronze bearings, adjustable for wear, are used in mounting the headstock spindle

The carriage is strong and deep with a wide bridge capable of supporting a heavy cut and the cross feed is fitted with a micrometer collar graduated in thousandths of an inch The apron is provided with a pair of half-nuts which are fitted and hand scraped and held by gibs The power longitudinal feed is obtained by clamping these half-nuts on the lead screw This feed has ample power



The Nine Inch Junior South Bend Lathe

as it is operated by the feed gears at the head end of the lead screw

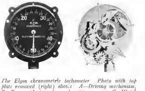
The compound rest is graduated to 180 deg. on the base and the feed screw is fitted with a micrometer collar graduated in thousandths of an inch The lead screw is a precision screw with an Acme Standard thread and made of special steel. A heavy and rigid tailstock is provided with a long bearing surface on the bed The longitudinal power feed has a range of fine to coarse feeds which are adjusted by the aid of the change gears which are attached to the head end of the lead screw This feed can be operated to make the carriage travel either right or left.

Standard screw threads from 4 to 40 per in. including 11½ pipe thread, right or left hand, can be cut A number of attachments for this lathe are offered

Elgin Tachometer

THE ELGIN chronometric tachometer offered by the Tachometer Division of the Elgin National Watch Co, 35 East Wacker Drive, Chicago, Ill, indicates directly in r.p.m the speed of any rotating member This speed may be carried to the tachometer through a flexible shaft or by an adaptor; the latter being the case when the tachometer is used portably

The driving mechanism takes the power from the flexible shaft, or adaptor, transmitting it to the power plant. The power plant furnishes the power for driving the watch mechanism, the counting mechanism and the synchronizing cams The watch mechanism times the



The Elgin chronometric tachometer Photo with top plate removed (right) shows A—Driving mechanism, B—Power plant and synchronizing cams, C—Watch mechanism, D—Counting mechanism E—Intermediate unit

action of the synchronizing cams, while the counting mechanism counts the revolutions transmitted to it during periods of one second each, and indicates the result on the dial

According to the manufacturer, the Elgin chronometric tachometer is positively gear driven, is not influenced by external forces, is dead beat, indicates accurately in both directions of rotation, and is of unalterable calibration

"Oil-Chek" Piston Ring

THE SIMPLEX Piston Ring Company of America, Inc, Cleveland O, has recently perfected and introduced the new Simplex "Oil-Check" piston ring This ring functions under the check-valve principle and serves as a positive means of oil control

This new type piston ring is not a substitute for the regular Simplex piston ring but is an addition, designed for a specific purpose—to stop oil pumping only in motors in which piston clearances do not exceed 0015 in per inch of diameter The Oil-Chek piston ring is also suitable for use in new engines

Like the regular Simplex piston ring, this new Oil-Chek ring embodies the now familiar patented principle of up-and-down expansion in the ring groove and the ability to mold itself to cylinder wall irregularities One Oil-Chek ring per cylinder is sufficient—always installed in the groove just above the wrist pin It can be used wherever any regular piston ring is used by simply removing the old piston ring and slipping on the Oil-Chek

Aerovanes

A COMBINATION airway and highway marker has been developed by the Aerovane Utilities Corp, 292 Madison Ave, New York City These products are now being installed by many air minded towns and cities

The "Aerovane" is erected in clear, open spaces, right off the main automobile highways leading to municipalities It is of all steel construction The structural steel mounting pole is 30 ft in height Anchored to the top of this pole is a red windsock, 5 ft long, which gives the aviator his ground wind direction. Seven feet below the windsock, centered on a horizontal plane, is a large arrow 13½ ft in length and, painted on this arrow in black, against a chrome yellow background, is the name of the town the pilot is approaching Superimposed on the tail of the large arrow is a smaller arrow pointing true north

An "Aerovane" erected near Chicago, Ill

The 4 x 10 ft. panel immediately beneath the arrow is used for road travel information and suspended from this panel are two plates 4 x 5 ft, which can be used for advertising purposes

An Aerovane is clearly visible at 1,000 ft and thus an aviator by following any main artery of ground travel, can easily pick up an Aerovane, the presence of which is readily identified by the distinctive color of the windsock, ascertain his ground wind direction, name of the town he is approaching and get his compass bearing

Shock Absorber Products

SHOCK ABSORBER cord in a variety of forms and sizes is offered by the B F Goodrich Rubber Co, Akron O This shock absorber cord meets recent Army Air Corps and Navy specifications and is made in ⅜, ½ and ⅝ in sizes Ring type cord specially adapted to split landing gear and tail skids may also be furnished in the same diameters to inside circumferences of 22, 25, 30, 35, 40 and 45 in.

Great tension and elongation are obtained in this cord by weaving a jacket of specially treated cord on rubber threads while they are stretched approximately 100 per cent The jacket cord is treated to resist weathering and wear

Goodrich shock absorber discs are lathe cut and ground from hand made tubing to obtain accurate dimensions and the best advantage of grain in the rubber These discs can be furnished in any size and quantity Soft medium and hard compounds are available so that various degrees of resiliency may be obtained by combining discs of different degrees of hardness Metal spacers may be inserted between the rubber discs to establish greater compactness at intervals

The company includes tables on load deflection tests on the three different grades of rubber discs in its general catalogue of aeronautical products which will be sent to persons interested on request

Lamps for Airport Lighting

A NEW line of lamps has just been offered for airport lighting by the National Lamp Works of General Electric Co, Nela Park, Cleveland, O Five lamps especially designed for aeronautical uses are included

The 10,000 watt (10 kw), 115 volt, aviation field floodlight lamp has a prong type of base and should be mounted base down It can be used in either reflector or lens type projectors The 5,000 watt (5 kw), 115 volt aviation field floodlight lamp, for use in either lens or reflector equipments also is fitted with the prong base and should be burned base down

To produce a narrow spread of light in a vertical plane the 3,000 watt (3 kw), 32 volt, field floodlight lamp has been developed It is designed for either lens or reflector type projector units The prong type of base is used The 1,500 watt, 32 volt, lamp is recommended for field floodlight or advertising beacons For a field floodlight lamp, its application is the same as for the 3,000 watt lamp Where a strong beam of light is required, as in advertising beacons, this lamp is very effective The lamp is fitted with the prong base and should be mounted base down

New General Electric lamps Left to right 10 kw, 5 kw and 3 kw field floodlight, advertising beacon and airport beacon type

The 1,000 watt, 115 volt, standard airway and airport beacon lamp is designed to give a narrow, intense beam of light It is fitted with the mogul screw base Base down burning is recommended for this type of lamp

AC Flame Arrester

A DUAL air cleaner-flame arrester has been developed that removes all hazards due to carburetor backfires from airplane engines This device is the result of long research work by engineers of the AC Spark Plug Co, Flint, Mich and has been tested and approved by the National Board of Underwriters According to the underwriters' report no flame can be made to pass through the air cleaner-flame arrester even under the most severe conditions

The device, attached to the intake of the carburetor also prevents dust particles from reaching the engine The dust as it comes in contact with copper ribbons in the apparatus adheres to the oiled surfaces and is retained there The cleaning element should be washed in gasoline and re-oiled at regular intervals to maintain its efficiency

The principle of the flame arresting feature is the quenching of the flame by a material which will absorb it at such a rate that the gas is cooled below the point of ignition This material consists of flat copper ribbon knitted and arranged in a container so that any flame emerging from the carburetor inlet must pass through

Schools —

How Will You Attract Your Students?

BY excellence of instruction, of course, which will bring, in years to come, a fine repute. For that there is no substitute. But what is the answer to the problem in the meantime?

Authorities at the Chicago Aeronautical Exposition estimated an increase of from 500% to 800% in the number of flying schools for 1929. The competition to secure students will be keen.

Beauty is a convincing influence upon a man buying a car. Even more, beauty appeals to the flying student. Combine this beauty with sturdy construction and ease of handling as has been done in the Mohawk "Pinto," and you have the ideal school plane.

Complete information about the Mohawk "Pinto" will be sent upon request. Also distributors' proposition for schools and other responsible persons or organizations.

Write or wire at once.

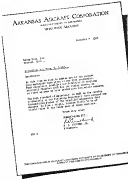
MOHAWK AIRCRAFT CORPORATION

Mohawk Aircraft
CORPORATION

2603 Delaware St., S. E., Minneapolis, Minnesota, U. S. A.

Approved Type Certificate No. 95, U. S. Department of Commerce

BERRYLOID *boosts* *Command-Aire sales*



ARKANSAS AIRCRAFT CORPORATION
MANUFACTURERS OF AIRPLANES
LITTLE ROCK ARKANSAS

November 7 1928

Yours very truly

President.

"We find a bright, durable finish to be of untold value in the ready sale of Command-Aire planes." This brief sentence, an extract from the letter at the left, accounts in part for the general use of Berryloid, the high luster lacquer, on the commercial ships manufactured in this country.

PROGRESSIVE AIRCRAFT FINISHES

Berry Brothers is constantly strengthening its position in the aircraft industry. Examination of the airplanes exhibited at the Chicago show reveals the fact that Progressive Aircraft Finishes are used by practically every builder.

Any Berry Brothers' customer will tell you why.

Progressive Aircraft Finishes carried in stock for immediate shipment by

Central Wall Paper & Paint Co., *Indianapolis, Indiana*
Johnson Airplane & Supply Company, *Dayton, Ohio*
Nicholas-Beazley Airplane Co., Inc., *Marshall, Missouri*
Paul R. Braniff, Inc., . . *Oklahoma City, Oklahoma*
Woodward, Wight & Co., . . *New Orleans, Louisiana*

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Varnishes Enamels and Lacquers
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THE CHOICE

of Those Who Know:

LAIRD'S unending string of air victories prove the high standards of durability and reliability built into each Laird plane.

There's a vital reason when one make of plane so consistently proves the winner in race after race. In the gruelling elimination of contest after contest standard Laird planes have been consistently winning:

- First in 1928 Los Angeles Closed Course Event No. 4.
- First and Second in Los Angeles-Cincinnati Air Derby.
- Both First and Second in the '27 National Air Derby.
- Second in 1928 Class B National Air Derby

For fast, practical, and dependable air transportation, Laird proves itself outstanding in reliability as well as speed. This *habit of winning* demonstrates Laird's *extra* dependability—the factor that enables you in a Laird plane, to come through when needed.

The Ideal Model for Commercial Transportation

The Laird cabin-ship has been a major development of the commercial air travel. A constantly increasing number of firms and business executives are finding fast transportation in these safe cabin ships—enclosed and finished in de luxe comfort. We welcome the opportunity of offering free demonstrations to responsible parties.

Profitable Distributor Franchise Open

In a few open territories Laird's Distributor proposition offers unusual opportunity to parties with airport facilities and funds to handle the sale of Laird Commercial planes.

The growing list of Laird owners is a gratifying sign of recognition from those best qualified to know.

E. M. LAIRD AIRPLANE COMPANY - 4500 West 83rd Street, Chicago, Ill.

Not connected in any way with any other manufacturer of airplanes. Laird Planes are made only at the E M Laird Company factory, Ashburn Field, Chicago Ill.

The AMERICA, which carried Commander Byrd to France, was equipped with Exide Batteries for radio reception.

The FLOYD BENNETT is equipped with Exide Batteries

Byrd Antarctic Expedition

uses Exide Batteries exclusively

Bark CITY OF NEW YORK, equipped with a 60-cell Exide for emergency radio operation

Over the North Pole . . . across the Atlantic . . . to the South Pole . . . these dependable batteries accompany Commander Byrd

AGAIN a Byrd Expedition chooses Exide Batteries. This time to the South Pole. Exide Batteries are on the "City of New York" . . . Exide Batteries on the dog-sleds . . . Exide Batteries on the "Floyd Bennett" as it zooms over Antarctic wastes.

For these dependable batteries proved themselves on the Arctic Expedition in 1925 and on the Byrd North Pole Flight in 1926. They were faithful again on the Byrd Transatlantic Flight to France in 1927 And now, in 1928 and 1929, they're proving themselves once more.

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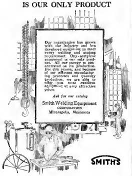

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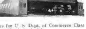

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CONTENTS

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January, 1929

The Modern Aerodynamic Theory *in* Design

By Ivan H. Driggs
Vice Pres. & Mgr. Driggs Aircraft Corp.

In the last few years the Prandtl Theory has come to be recognized as a very useful principle in the hands of the airplane designer or technician. However, full use is not generally made of the simplifying formulae resulting from it. The average person is too prone to hold to old ideas. The writer feels that a fuller use and understanding of this theory will greatly clarify the thinking upon the subject of the factors that affect airplane performance.

This article is written to assist in the above undertaking and it will set forth a few formulae that have resulted from the study of the subject. Part of these expressions are original and some are due to other writers. No attempt will be made to prove the truth of the general theory of Induced Drag as first suggested by Dr. Prandtl. The reader is referred to any modern text book on this subject for the general proof.

According to Dr. Prandtl the drag of an airplane wing in a perfect fluid, i. e. a fluid without viscosity, is given by

$$D = L^2/\pi qb^2 \tag{1}$$

Where D = drag
L = lift
$q = \frac{1}{2}\rho V^2$
b = span

He also states that the same formula may be applied to the multiplane if a correction factor to be applied to the value of the span, b^1. This correction factor is greater than unity so that the value of b used in the above expression is greater than the actual span of the cellule in the case of the multiplane. The value of this factor is about 1.1 for the average biplane, so that

$$b = 1.1\ b^1$$

where b^1 = actual span of cellule.

Equation (1) may be expressed in the form of coefficients as follows,

$$C_i = C_l^2/R \tag{2}$$

Where C_i = induced drag coefficient
C_l = lift coefficient
R = aspect ratio = b^2/S
S = total wing area

expressed in engineering units of lb. per sq. ft.-mi. per hr. equation (2) becomes

$$K_{xi} = .125\ K_y^2/R \tag{2a}$$

In figure 1 has been plotted the above expression for wing drag as found by Prandtl and the actual measured drag of the Clark Y aerofoil. It can be seen that the theoretical and the actual curves disagree by a practically constant amount below the angle of maximum lift. This does not necessarily prove an error to the theory but rather that all the facts are not considered by it. In the mathematical treatment from which Dr. Prandtl derived expression (1) it was necessary to assume a fluid without viscosity. This assumption is not strictly true in the case of the atmosphere and consequently we have the difference as shown by Fig. 1.

By testing a number of aerofoils of different aspect ratios but of the same section it has been found that the difference above noted is in all cases the same. This quantity is then a function of the wing section only and is called section drag.

One of the first uses to which equation 1 was put was the correction of wind tunnel results of one aspect ratio to apply to a cellule of another ratio. This correction is done by means of the following equation, correcting from aspect ratio A to aspect ratio X,

$$C_{dx} = C_{da} - C_l^2/\pi(1/A - 1/X) \tag{3}$$

$$\text{or } (K_x)_x = (K_x)_a - .125\ K_y^2(1/A - 1/X) \tag{3a}$$

Equation (3) is now the standard method used by practically everyone to transfer the wind tunnel results at one aspect ratio to any other, or to correct for biplane effect. The value of the aspect ratio to be used in the above expression is *not* the span divided by the chord but the expression,

$$R = (kb^1)^2/S.$$

When we consider the complete airplane we must introduce one more division of the drag, namely that due to the fuselage, landing gear, tail surfaces and structural bracing. This resistance has been called very properly the parasite drag since it produces no useful work. We then have three parts to the resistance of the complete airplane.

1. The induced drag = $L^2/\pi qb^2$
2. Wing section drag = $C_s qS$
3. The parasite drag = $C_p qS_p$

The wing section drag and the parasite drag are similar and may be grouped together under parasite as a division representing the difference between the total drag and the induced drag. That is,

$$D_t = L^2/\pi qb^2 + 1.28qS_p \tag{4}$$

where the value of the area, S_p, is made up of the wing section drag as well as the structural parasite.

In Fig. 2 we have plotted the polar curve for the VE-7 airplane as determined from full flight test. This curve shows that the value of S_p is practically constant throughout the range of angles investigated. The dotted curve is given to show the actual deviation from the above assumption. It is true that all airplanes may not show such agreement, but the VE-7 is a fairly representative type and there are probably other airplanes that are considerably better in this respect. In all cases of full flight analysis that the writer has carried out the agreement between the two curves has been equally as good and better in a few cases.

This discussion has been given to show that the principles given in the preceding paragraphs very closely follow the facts as shown by the full flight polar of a specimen airplane. A great number of the engineering formulae used every day show discrepancies from the actual facts as great, if not greater, than those shown in this case. Their simplicity and ease of application justify them. We believe that in this case, also, the simplicity of equation (4) and the great number of laws that may be derived from it fully justify and recommend the above assumptions for general use.

If we differentiate equation (4) with respect to q and place the result equal to zero for a minimum we find

$$dD_t/dq = 1.28\ S_p - L^2/\pi q^2 b^2 = 0$$

$$1.28qS_p = L^2/\pi qb^2$$

This demonstrates a very interesting and useful principle, i.e. *at the velocity of minimum drag the induced drag equals the parasite drag.*

$$q(\text{min. drag}) = L/2b\sqrt{S} \tag{5}$$

$$V(\text{min. drag}) = (14\sqrt{L}/\sqrt{b}\,\sqrt[4]{S_p}) \tag{5a}$$

Substituting in equation (4) we have the minimum drag

$$D_t(\text{min.}) = 1.28L\sqrt{S_p}/b \tag{6}$$

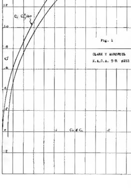
Since the value of ρ, the density of the air, does not occur in equation (6), the minimum drag is independent of altitude, and depends only on the weight (equivalent to L), the parasite area and the span.

From equation (6) we may find the value of the maximum L/D. Since the weight is constant and equals L, the max. L/D is given:

$$L/D(\text{max}) = .782b/\sqrt{S_p} \tag{7}$$

This is a very useful expression and can best be remembered as:

The maximum L/D equals three-fourths of the equivalent wing span divided by the square root of the parasite area in sq. ft.



To show the type of results obtained we will take the following example:

Let b = 30 ft.
S_p = 5.5 sq. ft.
Then $L/D(\text{max.}) = .782 \times 30 \div 2.34 = 10$
If S_p = 9 sq. ft.
$L/D(\text{max.}) = .782 \times 30 \div 3 = 7.8$

Both of the above results are very reasonable, in fact the writer has checked a great number of model tests and found surprisingly close results between all of them and the above equation.

Formula (7) is especially useful in connection with calculations using Breguet's expression for range or endurance as well as the equations for performance developed by Lieut. Walter S. Diehl.

The methods employed above are capable of demonstrating some very interesting rules for use with the design of gliders or soaring machines. Equation (7) of course is directly applicable to the case of the glider in which case the problem is to glide the greatest distance from a given starting point. Provided that sufficient area is provided that the speed given by formula (5) can be attained at a lift coefficient not too close to the maximum, the maximum distance that can be obtained by any glider from a given starting point will depend upon the span and parasite only and is given by

$$D = .782\ Hb/\sqrt{S_p} \tag{8}$$

Where D = Max. distance from starting point to end of flight,
H = Height of start over end of flight.

If we consider an airplane gliding downward at a speed V with a gliding angle of α, and if u equals the speed of vertical descent

$$u = V \sin \alpha$$

or for small angles

$$u = V \tan \alpha$$

but $\tan \alpha = D/L$

therefore $u = VD/L$

Substituting the value of D_t from equation (4) and then differentiating the value of u with respect to V for a minimum we find that the value of u is a minimum when

$$q = .289L/b\sqrt{S_p} \text{ in absolute units} \tag{9}$$

$$V = 10.62\sqrt{L}/\sqrt{b}\,\sqrt[4]{S_p} \text{ engineering units} \tag{9a}$$

Substituting equation (9) back into equation (4) and the expression for u we find the value of the minimum sinking speed,

$$u\ (\text{min.}) = 1.12\sqrt{L}\,\sqrt[4]{S_p}/\sqrt{\rho}\sqrt{b^3} \quad \text{absolute} \tag{10}$$

$$u\ (\text{min.}) = 15.68\sqrt{L}\,\sqrt[4]{S_p}/\sqrt{b^3} \quad \text{engineering} \tag{10a}$$

but $L = C_L Sq$ or $L = K_y SV^2$

Substituting in equation 9 we find

$$S = 3.46b\sqrt{S_p}/C_L \text{ absolute} \tag{11}$$

$$S = .0088b\sqrt{S_p}/K_y \text{ engineering} \tag{11a}$$

This is the area to give the soaring machine in order that the value of the sinking speed as given by formula (10) may be realized. The value of C_L or K_y used in the above expression should not be the maximum lift coefficient but should be somewhat less. The actual value used should be approximately at that point where the flow is still stable and the polar curve of the wing is still following the theoretical induced drag polar.

It is seen from the above expressions that the weight of a soaring machine does not determine its area nor does the weight enter into the expression for minimum sinking speed to a very large degree. This explains why some of the most successful German soaring machines have been somewhat heavy but have enormous spreads and are as clean as possible. The designers have sacrificed weight in building structures that are very clean and have

a very great wing weight due to excessive spans The planes are made as clean as possible in order to keep down the necessary wing area as given by formula (11) The writer does not want in any way to give the impression that weight is not important in the case of a soaring machine, but rather that it is not of major importance. An example will be used to illustrate the point.

let $b = 40$ ft
$S_p = 2$ sq ft
$C_l = 1\ 00$
$L = 400$ lb. $= W$
then $S = 3\ 46 \times 40 \times 1\ 414 - 1\ 00 = 196$ sq ft
u (min) $= 1\ 12 \times 20 \times 1\ 19 - 0487 \times 253$
$= 2\ 16$ ft per sec.

If the weight were increased 10%
u (min) $= 2\ 27$ ft per sec

If the span is increased 10%, the area S is also increased 10% with an attendant increase in weight of say 3%, but the value of the minimum sinking speed becomes

u (min) $= 1\ 12 \times 20\ 3 \times 1\ 19 - 0487 \times 292$
$= 1\ 9$ ft per sec

This is a decrease of 12% in minimum sinking speed If we were to go on increasing the span and therefore the area and weight we might finally reach a point where any further increase in spread would have such an effect upon the weight both due to increased area necessary and increased bending loads on the wings that no further decrease in the minimum sinking speed would result Although no increase in S_p was assumed in the above comparison actually an increase of wing area would affect that quantity to some extent This would naturally affect the optimum span that could be used for any problem

The whole question of the design of the soaring machine as far as aerodynamics is concerned is well covered by the above equations To the mind of the writer the problem of designing a soaring plane can be simply summarized as follows Make the fuselage, landing gear and tail surfaces as light and as clean as possible Choose an aerofoil with sufficient depth to provide strength and one with a small center of pressure movement The drag coefficient of the aerofoil at a point somewhat less than the burble point should be as small as possible With the above quantities determined apply equation (11) with an estimated value of the total parasite area and a chosen value of the span. From the area resulting check the value of S_p assumed and determine the total weight Find the value of the min sinking speed from (10) Repeat using various values for b and plot the results against b From such a curve it can very readily be determined which is the best span to use and the minimum sinking speed corresponding

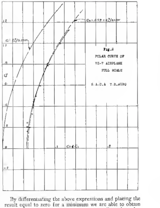
The problem is more complicated than the simple statement above due to the fact that there is no simple mathematical formula that gives the variation of wing weight with span and area The consideration of this problem is outside the scope of this paper, but the writer hopes to publish a paper at a later date that will consider this aspect of the question At present it would be necessary to design and calculate the weights of the various wings under consideration

In previous paragraphs we have considered the airplane as without power It is possible to write an equation of power required for flight from equation (4) as follows

$D_t = 637\ L^2/\rho V^2 b^2 + 637 \rho V^2 S_p$ rewriting equation (4)
$D_t = 125\ L^2/V^2 b^2 + 00327 V^2 S_p$ in engineering units

Multiplying through by V and dividing by 550 in one case and 375 in the other we have the equation of power required,

$P_r = L^2/3Vb^2 + 00000872 V^3 S_p$ engineering units (12a)
$P_r = 00116 L^2/\rho V b^2 + 00116 \rho V^3 S_p$ absolute (12)



By differentiating the above expressions and placing the result equal to zero for a minimum we are able to obtain the speed that gives the least power as well as the value of the least power

$dP_r/dV = 00348 \rho V^2 S_p - 00116 L^2/\rho V^2 b^2$
$00116 L^2/\rho V^2 b^2 = 00348 V^2 \rho S_p$

From the above equation it can be seen that *at the speed of minimum power the induced drag is three times the parasite*

$$q \text{ (min power)} = 289 L/b\sqrt{S_p} \text{ absolute} \quad (13)$$

$$V \text{ (min power)} = 10.62\sqrt{L}/\sqrt{b}\,\sqrt[4]{S_p} \quad (13a)$$

The above equations are the same as formulae (9) Therefore the speed at which we have the least power is the same at which the least sinking speed occurs

$$P_r \text{ (min.)} = 0066\sqrt{L^3}\,\sqrt[4]{S_p}/\sqrt{\rho}\,\sqrt{b^3} \text{ absolute} \quad (14)$$

$$P_r \text{ (min.)} = 042\,\sqrt[4]{S_p}\,\sqrt{L^3}/\sqrt{b^3} \text{ engineering units} \quad (14a)$$

These formulae are very different from those generally used in showing the dependance of the power required upon the airplane characteristics Generally, wing loading is considered the most important of those characteristics In these formulae, however, the ratio of Weight to Span or span loading is the most important The wing area enters into the equations in a secondary manner It is still important for the best possible performance from a given set of conditions Commonly the wing area is determined from the landing speed desired, with a tendency to increase that as much as possible in order to cut down the parasite This policy is correct if a racing plane is desired, but for commercial uses where weight carrying and economy are desired better results may be obtained by the uses of the formulae given in this paper In general all airplanes have too small a wing area for the optimum performance To illustrate this point we have calculated Table I The values of the quantities given were taken from full flight tests, and therefore do not contain any element of speculation. In all cases the value of C_l for equation (11) has been taken as unity, that is $C_l = 1\ 00$ In a paper to follow it will be shown that practically

TABLE I

Airplane	Actual Wing Area	Sp	b	k	Calculated Sw	Per Cent. Difference
H-1	802	24 35	46.	1 083	858	41%
XB1 A	408	13.5	39 4	1 087	545	34%
PW 1	269	9.3	32.	1 085	380	38%
MP 3	258 5	8 9	26	1 125	302	28%
JL-1	417	13.5	43 7	1 00	538	33%
VE 7	285	6.4	34 1	1.13	387	35%
DH-W. C	693	24 25	50	1 112	948	37%
CO 1	443	18 5	55 75	90	740	55%
CO-4	417	14.5	39	1 05	540	29½%
DT	336	8 6	25 3	1 08	372	15%
Messenger	152	5 5	26	1 18	175	15%
DH-4	440	17 53	42 5	1 12	690	57%
PW-8	262	8 1	32.	1.05	348	30%
MB-2	1121	58 5	74 2	1 04	2090	86%

all good aerofoils will give the minimum area according to formula (11) at the value of the lift coefficient

From the above table it can be seen that an increase of wing area would have allowed the value of the minimum power according to equation (14) to have been attained with a consequent increase in ceiling and minimum radius of turn, or in the case of the bombers, an increase in endurance It is true that the maximum speed would be diminished by an increase in parasite due to larger wings, but the speed at altitudes would not have been materially affected In fact a little closer study in the elimination of structural parasite would have been much more logical than the reduction of wing area to increase the high speed

To summarize, we have found a rational formula for the drag curve of an airplane over the useful range, and from that have determined the minimum drag and consequently the maximum L/D, and the velocity at which they occur From a resulting power equation we have also found the value of the minimum power and the speed at which it occurs We have shown that the wing area should be determined from the speed of minimum power rather than the landing speed desired We have also investigated the case of the glider and soaring speed and have given the minimum sinking speed for the soarer

There are numerous other uses to which these equations may be put By introducing an equation of Power Available we may easily find the maximum speed, the absolute ceiling, the minimum radius of turn, the maximum rate of climb at the ground and at any altitude, the maximum range and the maximum endurance. Also we may find a very rational way to classify different aerofoils and to choose the one best suited to a given problem The writer plans to take up the additional problems in later papers

TECHNICAL REVIEWS

Research Paper No. 35, Department of Commerce Bureau of Standards, by E. Z Stowell—This paper describes a method of transmitting unidirectional beacon signals for the aural or visual guidance of aircraft The method consists in transmitting directive and non-directive fields simultaneously with the proper phase and amplitude relations between them to secure unidirectional transmission.

These signals increase the efficiency of the beacon from the power standpoint, reduce interference from other beacons, and reduce the number of radiated courses to one It is believed that the polar characteristic of the radiated field is about the optimum for aircraft use

National Advisory Committee for Aeronautics, Technical Report No 294, The Measurement of Maximum Cylinder Pressures, by Chester W Hicks—The work presented in this report was undertaken at the Langley Memorial Aeronautical Laboratory of the National Advisory Committee for Aeronautics to determine a suitable method for measuring the maximum pressures occurring in aircraft engine cylinders The study and development of instruments for the measurement of maximum cylinder pressures has been conducted in connection with carburetor and oil engine investigations on a single cylinder aircraft-type engine Five maximum cylinder-pressure devices have been designed constructed, and tested, in addition to the testing of three commercial indicators

Values of maximum cylinder pressures are given as obtained with various indicators for the same pressures and for various kinds and values of maximum cylinder pressures, produced chiefly by variation of the injection advance angle in a high-speed oil engine It is the high pressure of short duration that is most difficult to measure, because the time of its duration is so short that little work can be done to operate an indicator

The investigations conducted thus far indicate that the greatest accuracy in determining maximum cylinder pressures can be obtained with an electric balanced-pressure, diaphragm or disk-type indicator so constructed as to have a diaphragm or disk of relatively large area and minimum seat width and mass

National Advisory Committee for Aeronautics, Technical Report No 292, Characteristics of Five Propellers in Flight, By J. W Crowley, Jr, and R E. Mixson—This investigation was made by the National Advisory Committee for Aeronautics at Langley Field for the purpose of determining the characteristics of five full-scale propellers in flight The equipment consisted of five propellers in conjunction with a VE 7 airplane and a Wright E-2 engine The propellers were of the same diameter and aspect ratio Four of them differed uniformly in thickness and pitch and the fifth propeller was identical with one of the other four with the exception of a change of the airfoil section The propeller efficiencies measured in flight are found to be consistently lower than those obtained in model tests It is probable that this is mainly a result of the higher tip speeds used in the full-scale tests The results show also that because of differences in propeller deflections it is difficult to obtain accurate comparisons of propeller characteristics From this it is concluded that for accurate comparison it is necessary to know the propeller pitch angles under actual operating conditions

National Advisory Committee for Aeronautics, Technical Report No 300 The Twenty Foot Propeller Research Tunnel of the National Advisory Committee for Aeronautics By Fred E Weick and Donald H Wood—This report describes in detail the new propeller research tunnel of the National Advisory Committee for Aeronautics at Langley Field, Va This tunnel has an open jet air stream twenty feet in diameter in which velocities up to 110 m p h are obtained Although the tunnel was built primarily to make possible accurate full-scale tests on aircraft propellers, it may also be used for making aerodynamic tests on full-size fuselages, landing gears, tail surfaces, and other aircraft parts, and on model wings of large size

Thrust Horsepower *and* Engine Efficiency

By LIEUT. COMDR. J. M. SHOEMAKER
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THE several fundamental requirements of an aircraft engine have been discussed by many The commonly accepted fundamental requirements, set down without reference to their relative importance, are

(1) Minimum weight per hp
(2) Maximum dependability
(3) Maximum durability
(4) Maximum economy
(5) Minimum cost
(6) Maximum ease of maintenance

In addition to the above requirements, I should like to present for consideration a requirement which, for want of a better name, I have called "Maximum effective thrust per horsepower" This requirement has to do with the effective thrust available in an aircraft power plant

An aircraft engine's direct output is brake horse power, while the output of the airplane power plant (which includes the propeller) is thrust horse power The t.hp developed is, of course, dependent on the efficiency of the propeller used The propeller should be so designed as to deliver the maximum t hp possible with the given conditions For purposes of comparison, it is assumed that this is the case,—that all the aircraft power plant types discussed have the most efficient propellers possible.

Aircraft engine design affects the effective thrust horsepower in two ways,—directly and indirectly The direct effect is the speed of rotation at which the engine develops its power The efficiency of a propeller increases with

$$\frac{V}{ND}$$

where V=speed of advance of the aircraft, N=speed of rotation of the propeller and D=propeller diameter

Hence, a high-speed engine with a propeller driven at crankshaft speed is less efficient than a slower turning propeller in the same aircraft (The slow-speed propeller will be of slightly greater diameter, but the effect of change in r.p.m. will be much greater and hence the latter will have much more effect on propeller efficiency) A high-speed direct-drive propeller may also suffer a loss of efficiency due to excessive propeller tip speed There is very little definite information as to the tip speed beyond which propeller efficiency falls off, but we have not been far wrong in assuming that it is in the neighborhood of 900 ft a sec

We see that the effect of high crankshaft speeds is to lower thrust horsepower directly due to its affect on peller

$$\frac{V}{ND}$$

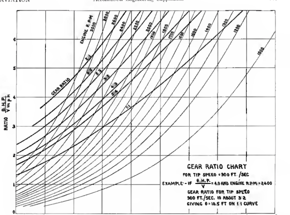
and on propeller tip speed Consequently, with high-speed engines it is necessary to incorporate reduction gearing between the crankshaft and the propeller shaft in order to reduce propeller speeds This reduction gearing is an additional complication due to its reduction of engine durability, dependability, and ease of maintenance and increase in engine weight per hp and engine cost In addition, the transmission of engine b.hp through gearing to the propeller shaft involves a slight loss in power, although this does not amount to more than a few per cent

Until recently, American practice in the use of reduction gears was to employ a 2 1 reduction ratio The latest ideas as to the choice of the proper reduction gear ratio take into account the increase in propeller diameter and propeller weight due to reduction gearing The disadvantage of increased propeller weight is self-evident Increase in propeller diameter, while maintaining the same ground (or structure) propeller tip clearance, not only requires additional weight of structure but the added length of supporting structure increases the parasite resistance of the aircraft For these reasons, the latest practice in regard to reduction gear ratios is to choose one which will give a value of

$$\frac{V}{ND} \text{ in excess of } 27$$

(where V=m.p.h., N=r.p.m. and D=ft.), and a propeller tip speed not greater than 900 ft per sec Working to these values will give a propeller efficiency somewhere near the maximum, and yet will insure that propeller diameter and weight are held to a minimum

The indirect effect of engine design on the effective t.hp. of an aircraft power plant is the drag (air resistance) of the engine as installed The thrust of the propeller overcomes the drag of an aircraft, of which drag that due to the engine is an important component So if the engine is of such a shape or size that its inherent air resistance is high, the effective thrust is proportionately diminished One of the drawbacks of the radial engine is its high drag This can be cut to a minimum by totally enclosing the engine with cowling, but with an increase in weight of structure and an evident sacrifice of visibility (in a single engine tractor installation)



The two factors—direct and indirect—which influence the effective thrust per hp. of an aircraft engine are themselves conflicting An engine which is designed to develop a certain b.hp at high r.p.m. will be smaller and lighter than a larger displacement slower turning engine of the same horsepower, and its air resistance in flight will be less The high-speed engine will probably require reduction gearing for the purpose of obtaining reasonable propeller characteristics, and this will add to the power plant weight and complication (and, in aircooled engines will call for additional care to insure proper cylinder and oil cooling)

The chart presented herewith was computed and drawn by Lieutenant Walter S Diehl of the Bureau of Aeronautics Navy Department It can be used both for the determination of the correct gear ratio and the approximate propeller diameter required with such a gear ratio In using this chart, care must be taken to insure that the b hp employed for the computation of

$$\frac{B\ HP}{V}$$

is the propeller shaft b hp This will be 2 or 3 per cent lower than the crankshaft b hp due to mechanical losses in the reduction gearing The propeller diameter obtained from this chart will be that of a conventional detachable-blade two-bladed metal propeller Should this be too great for use, a three-bladed propeller may be employed This will permit a reduction of propeller diameter to 0 95 that of a two-bladed propeller The substitution of a three-bladed for a two-bladed propeller will entail a loss in propeller efficiency of about 2 per cent

Proportioning *the* Plane *for* Lateral Stability

By B. V. Korvin-Kroukovsky

In our previous paper on Stability on Controllability of Airplanes[1] we gave quite comprehensive discussion on the subject of lateral stability. We explained the meaning of lateral stability, considered in turn all the elements on which it depends, and proceeded to consider the combined effect of these elements on flight of uncontrolled models. We extended the discussion further and analysed the effect of different types of lateral stability or instability on the action and "feel" of controls. Our discussion, however, was purely qualitative. Our aim was to explain the subject in such a way as to enable the test pilot to make correct diagnosis of the airplane he is testing, and to convey his information to the designer in terms, the meaning of which would be clear to both. The explanation of the problem was definite enough to show the designer the way to correct the defects of his machine after receiving the report from test pilot. The lack of quantitative data, however, made it impossible to predict the characteristics of the airplane in regard to aileron and rudder control from the design data. In this paper we will supplement our previous papers, and will give approximate formulae for proportioning the amount of dihedral and fin area, so as to obtain the desired kind and degree of lateral stability.

We defined the lateral stability as the ability of an airplane to maintain the flight in a straight line with the span of the wings horizontal, and the tendency to return to this attitude after each disturbance. The mathematical theory shows that lateral stability of an airplane in case of straight flight depends on nine different characteristics, and in case of curved flight it is involved in thirty-six different characteristics, making the problem exceedingly complicated. It shows mercy, however, attributing predominant importance to only two of these characteristics, namely to stability in roll and stability in yaw[2]. The stability in yaw and in roll is a necessary condition for the lateral stability, but it is not sufficient condition. The relation between the stability in yaw and the stability in roll is even more important than their individual values. The airplane will become laterally unstable if the stability in yaw is excessive, as well as if it is insufficient. The excess of stability in roll as well as the lack of it, leads to lateral instability. The whole problem of securing lateral stability is essentially that of balancing these two elementary characteristics.

Let us imagine a perfectly normal and well balanced airplane in a straight flight, and let it be suddenly banked by a gust of wind or by pilot's action. The force of gravity remains vertical, but the lift force of the wing remains normal to the span and therefore is inclined by the angle of bank, as this is shown in Fig. 1. These two forces, when added geometrically, leave the unbalanced component directed along the span of the airplane. This competent produces the side slip which brings into play the forces and moments affecting the lateral stability. Fig. 2 shows the airplane banking and sideslipping. The velocity of sideslip v added geometrically to the forward velocity U produces the angle of yaw ψ. As the airplane is sideslipping to the left, the air pressing on the vertical fin and rudder produces the yawing moment N_v. This

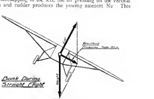


Fig. 1

moment yaws the airplane to the left, to head it into the relative wind with the angular velocity r. This tendency of the airplane to head into relative wind is known as the *stability in yaw*.

As the airplane yaws to the left under action of the moment N_v, generated by the fin action, its right hand wing moves forward and left hand one moves backward. This motion is combined with forward velocity U and results in right hand wing moving through the air with higher velocity than left hand one. The wing moving faster generates more lift than wing moving slower and the difference in lift generates the rolling moment L_r, tending to roll the machine in the direction of the original bank. Thus we find that presence of the vertical fin made the machine stable in yaw by generating the moment N_v, but it had secondary effect generating the moment L_r which is detrimental to stability in roll. It tends to roll the machine in wrong direction, and to increase the bank.

The side slip, however, acts directly on wings, as well as on fin and rudder. If the wings are set at a certain angle of dihedral, they generate the rolling moment L_v which is a stabilizing moment. This moment tends to lift the wing on the side of the side slip, i.e. when side slip is to the left it tends to lift the left wing, thus reducing the bank. Here now is the question of lateral stability in a nutshell. If the stabilizing moment L_v due to dihedral is some-

[1] For references see end of article

MANUFACTURERS' SPECIFICATIONS ON AMERICAN CO

THE TABLE BELOW IS BELIEVED TO BE ACCURATE BUT

This table will

MANUFACTURER	Designation	Price of Plane at Factory	Type	No. of Seats	Make of Engine	Total Rated HP.	Make of Propeller	Span	Wing Area (Sq. Ft.)	Length Overall	Height Overall	Weight Empty (Lb.) With Water if Water Cooled Engine is Used	Pay Load (Lb.)
Advance Aircraft Co.	Waco 10	$5 535	OBL	3	Sh10	125	H Hs,SS	30'7"	290	23'6"	9'	1330	570
Advance Aircraft Co.	Waco 10	$2 030*	OBL	3	OX5	90	Hs	30'7"	286	23'6"	9'	1225	560
Advance Aircraft Co.	Waco 10	$2 585*	OBL	3	E	150	H Hs,SS	30'7"	290	23'6"	9'3"	1308	600
Advance Aircraft Co.	Waco 10	$7 341	OBL	3	J5	200	H,Hs,SS	30'7	285	22'6"	9'3"	1550	600
Aero-Craft Mfg. Co.	Aero-Coupe	$5 200	SBL	3	W	110	F	32'	240	24'	8'8"	1100	540
Alexander Aircraft Corp.	Eaglerock A-1	—	OBL	3	J5	200	—	36'8"	330	24' 11"	9' 11"	—	—
Alexander Aircraft Corp.	Eaglerock A-2	$2 250*	OBL	3	OX5	90	—	36'8"	330	24' 11"	9' 11"		
Alexander Aircraft Corp.	Eaglerock A-4	—	OBL	3	E	180		36'8"	330	24' 11"	9' 11"		
American Eagle Aircraft Co.		$2 985	OBL	3	OX5	90	H Hs	30'	290	24 6"	8' 4"	1227	840
Fokker Aircraft Corp.	F 7 & C-2	$44 200	CML	10-13	3-J5	650	H	63' 4"	630	49' 2"	12 6"	5400	2000
Fokker Aircraft Corp.	Universal	$14 200	CML	5-7	J-5	200	H, Hs	47' 9"	341	33'	8 6"	2100	1200
Fokker Aircraft Corp.	Super Universal	$16 340	CML	5-8	P Ww	420	SS	50' 8"	352	36'	8' 11"	2350	1230
Fokker Aircraft Corp.	Fokker F 10	$60,000	CML	14	3-PWw	1200	SS	71'2"	728	49' 6"	12 6"	7200	2640
Arrow Aircraft Corp.	Arrow-Sport	$2 237	OBL	2	LB	60		25' 0"	178	19' 2"	6' 11"	826	
Bach Aircraft Co.	Air Yacht	$38 000	CML	10-12	3Sh12-pwa	650	2 Sty, SS	62'	412	36.4	9' 6"	3400	
Bellanca Aircraft Corp.	CH	$14 500	CML	6	J5	200	H	46' 4"	273	28 0	8 0	1850	2220
Berliner Aircraft Co.	CM4	$3 200	OML	3	OX5	90	H, Hs	36	210	23'10"	8	1400	
Berliner Aircraft Co.	CM5	$8 250	OML	3	J5	200	SS	36'	210	23'10"	9'	1775	
Bird Wing Commercial Airplane Co.	No. 6	$2 795	OBL	3	OX5	90	Hs	31 4"	312	23 6"	8' 2	[illegible]	550
Boeing Airplane Co.	40-B	$24 000	SBL	3	P Wh	400	H M	44'2"	543	33'4"	11'8"	3543	1428
Boeing Airplane Co.	40-C	$22 500	SBL	5	P Ww	400	H M	44'2"	545	33'4"	12'8"	3522	1440
Boeing Airplane Co.	B-1E	$28 500	CBF	6	P Ww	400	H W	39'8"	545	32'6"	12'	3050	700
Boeing Airplane Co.	B-1D	$34 000	CBF	4	J5	300		39' 8"	498	30' 0"	12'	2449	700
Bowdon Aircraft Corp.	Kitty-Hawk		OBL	3	Sh11	80	W	28'	231	22' 11"	8' 0½"	1110	
Breese Aircraft Co.			CML	6	J6	220	SS	41	280	27	10' 6"	1650	
Buhl Aircraft Co.	Airsedan-CS4	$13 200	CBL	6	J6	300	SS	42'	334	28	10'	2072	1200
Buhl Aircraft Co.	Airsedan CA-3C	$12,000	CQL	3-4	J5	200	M	36'	240	28'	8' 0"	1800	635
Buhl Aircraft Co.	Junior Airsedan	$6,000	CQL	3	W	110	M	36'	240	25'	8' 0"	1500	520
Cessna Aircraft Co.	2-100	$5 338	CML	6	A	100	H Hs	40' 6"	224	23 8"	7 4	1250	450
Cessna Aircraft Co.	4-125	$6 [illegible]	CML	4	Sh12	125	H Hs	40' 6"	224	23 8	7 4	1200	710
Cessna Aircraft Co.	6-00	$9 000	CML	4	J6	200	H Hs	40 6"	224	23 8	7 6	1316	810
Command-Aire Inc.	Command-Aire	$2 450*	OBL	3	OX5	90	H	31' 6"	300	24' 6"	8'	1275	650
Command-Aire Inc.	Heinkel H.D. 40	$25 000	CBL	2	PWw	400	M	67'	250	30'	14'	6100	2100
Crawford Mt. & A. Mfg. Co.	A1	$1,000	OML	2	LR	60	own	30'	160	17 0"	7'	650	
Crown Motor Carriage Co.	B1		OBL	2-3	K-5	100	S	28' 6"	236	21 3"	8' 3"	860	330
Curtiss-Robertson Airplane Mfg. Co.	Robin	$4 000	CML	3	OX5	90	Hs	41'	223	25' 0"	7 10"	1401	328
Driggs Aircraft Corp.	Dart II	$1 400	OBL	2	A3	90	Bs	25'	140	19' 0"	6'	450	
G. Elias & Bro. Inc.	Aircoupe	$3 350	CML	3	A	80	Elias	35' 1½"	192	21'	7'2"	870	818
Fairchild Airplane Mfg. Co.	FC-2W2 land		CML	6	P Ww	400	SS	50'	332	32'10"	9'4"	2781	
Fairchild Airplane Mfg. Co.	Ft. 6 land		CML	6	J6	220	CR	44'	300	30' 11"	9'	2100	840
Federal Aircraft Corp.	CM-1	$12,500	CM	6	J-6	300	Wo	37' 6"	259	29 3"	9'	2000	630
Gates-Day Aircraft Corp.	GD-24	$5 200	OBL	3	E	150	H	45'	350	28'	11'	1700	809
Bliss Aircraft Corp.	[illegible]		CBL	4	Sh10	125	Hm	33' 9	240	23'	8'7"		
Hamilton Metalplane Co.	H 45		CML	8	PWw	400	H	54 5"	387	34'8"	9 4"	3330	1153
Hamilton Metalplane Co.	H-47		CML	8	PWh	500	H	54' 6"	387	34' 8"	9 4"	3450	1545
Heath Airplane Co.	Parasol	$985	OML		H	30	own	30'	94	18' 0"	6' 11"	290	
International Aircraft Corp.	F 17	$7 950	OBL	3	OX5	90	H	35'	325	25	9' 6"	7080	300
International Aircraft Corp.	F 18	$12,250	CBL	6	J5	200	SS	37'	300	27' 8"	10' 0"	2200	650
Ireland Aircraft Inc.	Neptune	$14 000	CMA	6	J5	200	CR	40	350	31' 5"	11' 6"	2450	780
Irwin Aircraft Co.	M-T-3	$1 165	OBL	1	I70	20	own	20'	100	15' 0"	6 0"	270	100
Keystone Aircraft Corp.	Pronto		OBL	3	J5	200		30' 11"	255	24' 8"		1975	
Keystone Aircraft Corp.	Pathfinder		CBL	12	3-J5	600		66 0"	1100	46'		6556	1600
Kinner A. & M. Co.	Courier		OML	2	K	100	SS	35'	218	23	7'	933	
Kreider Reisner Aircraft Inc.	Challenger	$2 400*	OBL	3	OX5	90	Hs, B	30' 1"	285	23 8"	9' 4"	1200	410
E. M. Laird Airplane Co.	Commercial		OBL	3	J5	200	SS	34'	300	23 0"	9' 0"	1550	800
Laird Aircraft Corp.	Whippoorwill		CBL	4	J6	200		35'	251	27	9	1850	
Lincoln Aircraft Co.	Lincoln Page		OBL	3	OX5	90		32'	300			1200	300
Lockheed Aircraft Co.	Vega		CML	5-7	J5	220	SS Wo	41'	270	27' 6"	8' 6"	1550	1200
Lockheed Aircraft Co.	Air Express		CML	5-7	P Ww	400	SS	41'	278	27' 6"	8' 6"	1850	1260
Loening Aeronautical Engr. Corp.	Sea Amphibian	$60 000	CBA	5-7	PWw	400	SS	46'	200	34' 6"	13 2"	3400	1200
Mahoney Ryan Aircraft Corp.	Ryan B1	$12 200	CML	5	J5	200	H W	42'	280	27' 8"	8' 10"	1870	300
Metal Aircraft Co.	Flamingo G-1		CML	6-8	P Ww	400	SS	48'	354	30'	9'	2900	
Mono Aircraft Inc.	Monocoupe	$2 675	CML	2	V	65	Hs	30'	155	20' 6"	6 3"	100	
Mohawk Aircraft Corp.	Pinto	$2 750	OML	2	V	65		30' 6"	124	21'	6 3"	850	200
National Airways System Inc.	Air King	$2 385	OBL	3	OX5	90	Hs	34' 1"	270	23 5	9'	1250	
Niles Aircraft Co.	Wilbone		OML	1	Bs	40		28'	108	18	6' 0"	440	
Pheasant Aircraft Co., Inc.	H 10	$2 850	OBL	3	OX5	90	Hs	31' 6"	263	23' 6"	9'	1287	300
Pitcairn Aviation Inc.	Mailwing	$10 000	OBL	1-2	J5	200	SS	33'	282	22' 10"	9' 10"	1532	300
Pitcairn Aviation Inc.	Super Mailwing		OBL	1-2	J5	200		33'	252	22' 10½"	9' 3"	1640	—
Phoenix Aviation Inc.	F4-4		OBL	3	OX5	90	Hs	30'	220	21 10"	8' 7"	1125	
Prudden Aircraft Corp.	S E-1	$22,500	CML	8	PWw	410	SS	67'	427	38'	9' 6"	2000	1080
Richmond Airways, Inc.	Sea Hawk		OMF	3	C6	160		40'	317	28'		1300	
Sikorsky Mfg. Co.	S-37		CBL	18	2P Wh	1000		100'	1040	45' 8"	16' 0"	8600	4000
Sikorsky Mfg. Co.	S-38 Amphibian		CQA	10	2P Ww	800	SS B	71 8"	720	40' 3"	13' 10"	5900	2210
Simplex Aircraft Corp.	Red Arrow	$3 900	CML	3	K5	100	Sty	33' 9"	118	20 3"	6' 10"	1000	
Sterling Aircraft Co.			OBL	3	OX5	90		32		23' 4"	9	1237	
Stearman Aircraft Co.	C-2 B	[illegible]	OBL	3	Sh12	125	H Hs	35' 2"	280	24'	9'	1285	350
Stearman Aircraft Co.	C 3 P	[illegible]	OBL	3	J5	200	H CR	35 2"	290	23	9'	1425	400
Stinson Aircraft Corp.	SM-1 DX	$12 500	CML	6	J5	300	H	45 10"	292	32'	8' 8"	2400	1240
Stinson Aircraft Corp.	Junior SM-2	$6 950	CML	4	W	110	Wd	41 8"	270	28' 3"	7' 9"	1310	593
Spartan Aircraft Co.	C-3	$5 250	OBL	3	Wal	135		32'	292	23' 11"	8' 9"	1200	448
Stout Metal Airplane Co.	4-AT		CML	12	3J5	600	SS	74'	785	49' 10"	12 8"	[illegible]	2200
Swallow Airplane Mfg. Co.	Commercial		OBL	3	OX5	90		32'	300	24'	9' 0"	1470	380
Taylor Bros. Aircraft Co.	Chummy	$3 000	SML	2	K-5	100		28'	175	22	7 0"	950	100
Temple Aero Corp.	Temple		OML		J5	200		39' 4"	225	28' 10"	8' 0"		907
Thaden Metal Aircraft Co.	T 1		CML	7	P Ww	400		53		35	11	2000	
Thunderbird Aircraft Inc.	W-14-G	$3 550*	OBL	3	OX5	90	Sty	31'	278	24' 6"	8' 7"	1433	300
Thunderbird Aircraft Inc.	W-14-B		OBL	3	E	150	Sty	31'	278	24 8	8' 7"	1531	500
Travel Air Mfg. Co.	2000	$2 900	OBL	3	OX5	90	H, Hs	34' 8"	290	24' 2"	8' 9"	1350	350
Travel Air Mfg. Co.	4000	[illegible]	OBL	3	J5	200	H	34 8"	290	23 8"	8' 9"	1090	200
Travel Air Mfg. Co.	6000	$12 900	CML	5	J6	290	SS, B	48' 7"	282	31' 10½"	10' 8½"	2175	944
Travel Air Mfg. Co.	3000		OBL	3	Sh12	125	W	34' 8"	290	24 2"	8' 9"	1250	380
Wallace Aircraft Co.	Touroplane	$3,500	CML	3	A	80	Hs	37'	203	23' 6"	7' 6"	540	330
Whitten Aircraft	[illegible] Bird	$2 350	OBL	3	OX5	90	Hs	33' 1"	318	23' 8"	8' 3"	1050	450
Western Airplane Corp.	King Bird	$3 500	OBL	3	OX5	90	Hs	35'	330	23' 4"	9'	1200	600
Zenith Aircraft Corp.	Albatross	$35 000	CML	16	3 Sh12	975	Sty	80'	1033	50	13 8"	5000	5000

TYPE.
A—Amphibian
B—Biplane
C—Closed
F—Flying boat
L—Landplane
M—Monoplane
O—Open
Q—Sesquiplane
S—Semi-closed
W—Seaplane

ENGINE. One engine unless stated in italics.
A—Anzani
C6—Curtiss
E—Wright Hispano-E
FC—Fairchild Caminez
H—Henderson
I70—Irwin
J5—Wright Whirlwind
K—Kinner
L—Liberty
LB—Le Blond
LR—LeRhone
OX5—Curtiss
P Wh—Pratt & Whitney Hornet
P Ww—Pratt & Whitney Wasp
SR—Super Rhone
SH—Siemens Halske
Sp—Sprisly
V—Velie
Wal—Walter
W—Warner
*—Price without engine

PROPELLER.
CR—Curtiss Reed
B—Bamboo
Hs—Hartzell
M—Metal
Sty—Story
SS—Standard Steel
W—Wood
We—Westinghouse

MMERCIAL AIRPLANES AND SEAPLANES AS COMPILED BY *AVIATION*

AVIATION DOES NOT ASSUME RESPONSIBILITY FOR THE FIGURES GIVEN

er monthly and corrections and suggestions are invited

Disposable Load (Lb.)	Normal Gross Weight Loaded (Lb.)	Performance With Full Load at Sea Level As Supplied by Manufacturers. High Speed in M.P.H.	Cruising Speed in M.P.H.	Landing Speed in M.P.H.	Climb at Sea Level in F.P.M.	Climb to 10,000 in Minutes	Service Ceiling in Feet	Fuel Capacity in Gallons	Normal Range in Miles	Normal Fuel Consumption at Cruising Speed Gal. Per Hr.	Fuselage Construction	Wing Construction	Are Wings Wired for Lighting?	Type of Control	Brakes	Type of Shock Absorber	Type of Pontoon Provided for	Additional Cost as Seaplane	Dept. of Commerce Type Certificate Number	Performance Figure Guaranteed?	
300	2025	107	93	35	..	..		37	..	....	Wl-ST	Wd-F	Yes	SPD	Ex.	O-S	EFH	$1,100	26	....	Advance—Waco Siemens
300	2025	96	85	35	..	..	13,000	48	450	5	Wl-ST	Wd-F	Yes	SPD	Ex	O-S	EFB	....	13	....	Advance—Waco OX—5
392	2600	115	105	40	..	..	15,000	76	..	....	Wl-ST	Wd-F	Yes	SPD	Ex.	O-S	EFH	$1,100	42	....	Advance—Waco Hisso
350	2600	135	115	40	1200	..	18,000	65	..	12	Wl-ST	Wd-F	Yes	SPD	Ex.	O-S	EFH	$1,100	41	..	Advance—Waco W—J—5
90.	2100	110	100	38	900	..	12,000	44	460	6.6	Wl-ST	Wd-F	Yes	SD	B	Arl	....	$1,000	Apl.	Yes	Aero-Craft—Coupe
..	2491	130	..	39	1080	..	17,900	..	..	...	Wl-ST	Wd-F	....	SCD	...	RC	E	...	56	..	Alexander—Eaglerock A-1
...	2442	100	87	34	514	..	11,500	46	435	10.3	Wl-ST	Wd-F	....	SCD	...	RC	E	...	7	Yes	Alexander—Eaglerock A-2
..	2618	121	..	40	840	..	14,700	..	..	...	Wl-ST	Wd-F	....	SCD	...	RC	E	....	58	....	Alexander—Eaglerock A-3
330	2057	101	85	30	575	45	12,000	42	425	7.5	Wl-ST	Wd-F	Yes	SPD	Ex	RAR	E	$990	17	Yes	AmericanEagle
320	9060	122	100	35	720	24	12,500	185	560	32	Wl-ST	Wd-P	Yes	DeCD	Yes	RAR	..	..	Apl	....	Atlantic—Fokker F7 & C-2
900	4000	115	98	45	500	40	11,500	75	600	12	Wl-ST	Wd-P	Yes	SCD	Yes	RC	M	$2450	9	....	Atlantic—Fokker Univ.
700	5000	140	115	42	1000	.5	18,000	120	700	20	Wl-ST	Wd-P	Yes	SCD	Yes	RAR	M	$3110	Apl	5%	Atlantic—Super Univ.
960	11500	145	125	55	1400	10	18,000	285	580	60	Wl-ST	Wd-P	Yes	DeCD	Yes	RAR	....	...	..	....	Atlantic—Fokker F-10
50	974	105	..	55	680		15,200	.	..	..	Wl-ST	Wd-F	....	S	....	RC	....	....	..	....	Arrow—Sport
200	6500	150	110	45	1100	12	16,000	170	500	32	Wd-P	Wd-F	Yes	DeCD	S-B	By-C	...	...	..	Yes	Bach—Air Yacht
284	5134	122	110	46	850	.	13,000	92	600	10	Wl-ST	Wd-F	Yes	SCD	Yes	RC	D	....	47	....	Bellanca—CH
300	2300	105	85	41	450	40	13,000	37	400	5	WEST	Wd-F	Ex.	SPD	Ex.	O-S	None	....	39	5%	Berliner—CM-4
325	2700	130	110	45			..	60	550	12	Wl-ST	Wd-F	Ex.	SPD	B	O-S	None	....	Apl	5%	Berliner—CM-5
319	2255	90	80	30	460	80	10,000	55	325	9	Wl-ST	Wd-F	Yes	SC PD	Ex.	RC	..	$890	Apl	Yes	Biro Wing—No. 5
336	6079	132	..	57	800	16.5	15,100	140	..	25	Wl-ST	Wd-F	Yes	S	S	O	....	....	27	....	Boeing—40-B
353	6075	129	..	57	600	25.3	12,000	140	..	20	Wl-ST	Wd-F	Yes	S	S	O	....	....	54	....	Boeing—40-C
160	4550	115	..	59	1000	15.5	12,000	60	..	20	Wd	Wd-F	Yes	De	....	....	....	....	..	....	Boeing—B-1E
100	3442	95	..	52		.	12,000	40	..	...	Wd	Wd-F	Yes	DeD	....	..	...	..	23	....	Boeing—9-1D
..	1883	110	90	40			12,000	37.5	.	6.5	Wl-ST	Wd-F	...	SPD	....	RD	...	....	Apl	....	Bourdon Kitty Hawk
300	2550	121	115	43	900	.	15,500	60	550	9.5	Wl-ST	Wd-F	...	...	....	RC	...	....	..	....	Breese
325	5700	120	95	50	[illegible]	45	14,500	70		15	Wl-ST	Wd-F	Yes	SC	Yes	OS	Met	$2,500	33	....	Buhl Airsedan
300	3200	139	115	45	900	15	14,000	00	700	14	Wl-ST	Wd-F	Yes	SP	Yes	OS	Met	$3,000	46	5%	Buhl Special Airsedan
300	2500	110	90	40	600	25	11,000	..	600	7	Wl-ST	Wd-F	Yes	SP	Yes	OS	Met	$2,000	Apl	5%	Buhl Junior Airsedan
750	2000	125	100	45-50	1000	..	...	42	400	10	Wl-ST	Wd-F	Yes	SPD	Ex.	RAR	....	....	Apl	5%	Cessna Aircraft Co.
330	2280	1.	1.5	45	1000	..	...	4.	400	10	Wl-ST	Wd-F	Yes	SPD	Ex.	RAR	....	...	Apl	5%	Cessna Aircraft Co.
070	2420	1?1	12?	45-50	1400	..	..	42	400	12	Wl-ST	Wd-PF	Yes	SPD	Ex	RAR	....	....	Apl	5%	Cessna Aircraft Co.
300	2075	104	85	36	550	..	10,000		400	....	Wl-ST	Wd PF	Yes	B	No	RC	E	$1,100	53	...	Command-Aire
400	...	140	.	54	..	..	18,000		600	....	Wl-ST	Wd PF	Yes	DeD	Yes	Arl	M	$2,000	..	5% N	Heinkal H.D. 40
350	1400	90	64	47		..	13,000	40	500	5	ST Wd	Wd-F	No	D	....	RC	....	....	No	5%	Crawford A1
501	1500	110	90	35	750	48	14,000	27	400	6	Wd	Wd-F	No	SD	No	Grs	....	....	Apl	Yes	Crown—93
725	2217	101	85	46	400	..	11,500	50	607	7	Wl-ST	Wd-FD	Yes	S-PC	No	RAR	....	....	40	5%	Curtiss—Robin
370	820	85	75	46	560	..	15,000	15	375	3	Wl-ST	Wd-FD	Yes	SC	No	RAR	None	...	15	5%	Driggs—Dart II
564	1334	96	80	25	500	..	10,000	20	400	4	Wl-ST	Wd-F	Yes	SC	No	Elias	None	....	..	....	Elias—Aircoupe
719	5500	140	110	55	1050	13	17,500	160	600	20	Wl-ST	Wd-F	Yes	S-CP	Yes	Hy	F	....	61	....	Fairchild—FC-2W 2 land
356	5650	122	105	53	850	27	15,100	110	710	15.5	Wl-ST	Wd-F	Yes	S-CP	Yes	Hy	F	....	10	....	Fairchild—FC-2 land
395	3475	125	105	40				54	750	10	Wl-ST	Wd	Yes	SC	Yes	Arl	....	.	..	....	Federal Aircraft—CM-1
300	3000	115	95	35	800	14	16,000	56	600	....	DR-F	Wd-F	Yes	SCP	Ex.	O-S	E	$2500	Apl	5%	Gates—Day—New Standard
	2400	110	90	45	600	.	11,000	45	420	....	Wl-ST	Wd-F	Yes	DeD	B	O	....	..	..	....	Gillis—Crusader
408	5750	135	115	50	950	20	16,000	140	600	21	D-cor	D-cor.	Yes	Da	Yes	Arl	H	$2500	..	5%	Hamilton—H-45
100	5750	140	120	55	1000	16	15,000	140	600	23	D-cor	D-cor	Yes	Da	Yes	Arl	H	$2500	..	5%	Hamilton—H-47
225	515	70	65	32	200	.	...	3.3	120	....	R-ST	Wd-F	No	SC	No	RC	....	...	..	....	Heath—Parasol
320	2100	100	87	35	600	..	10,500	40	450	....	Wd	Wd-F	Yes	S	Ex	O	....	....	55	....	International—F-17
350	3750	125	110	40	850	..	14,000	67	500	....	Wd	Wd F	...	S	Std.	O	....	...	Apl	....	International—F-18
358	3008	95	85	46	650	55	11,000	65	500	12	ST-D	Wd F	Yes	DeD	No	OC	....	...	Apl	5%	Ireland—Neptune
300	575	90	75	28	400	55	12,000	5	300	1.7	Wd	Wd F	Yes	SC	....	RC	W	$175	..	5%	Irwin—M-T-2
310	3285	112	..	..	500	..	14,000	50		....	Wl-ST	Wd-F	....	....	....	....	....	....	..	....	Keystone—Pronto
351	10841	112	..	57	570	..		..	500	....	Wl-ST	Wd-F	....	....	....	..	....	....	..	....	Keystone—Pathfinder
550	1465	120	110	35	900	..	20,000	..	800	7	Wl-ST	Wd-F	....	....	S	Gr	....	....	..	....	Kinner—Courier
111	2000	102	..	39	545	..	12,000	..	400	....	Wl-ST	Wd-F	Ex	SD	No	RC	EH	$1,100	19	5% N	Kreider-Reisner—Challenger
		130	10	40	1350	10	...	60	600	....	DT, S	Wd-F		SPA			....	...	..	....	E. M. Laird—Commercial
300	2650	125	105	40		15	...			....	Wl-ST	Wd-F	Yes	DeD.	Std	RC	....	...	..	....	Laird—Whippoorwill
300	2200	100	.	35	600	..		42	500	....	Wl-ST	Wd-F	..	..	...	..	....	...	28	....	Lincoln—Page
550	3200	135	110	50	1000	16	15,000	100	700	10	W-mon	Wd-P	Yes	SC	H	RC	E	....	Apl	5%	Lockheed—Vega
345	3845	137	135	55	1450	10	17,250	100	1000	18	W-mon.	Wd-P	Yes	SC	H	RC	....	...	Apl	5%	Lockheed—Air Express
300	5400	120	..	50		..	14,000	140	850	....	Wd-D	Wd-F	Yes	DeC	Ex.	RC	....	...	54	....	Loening—Amphibian
130	3300	126	108	49	1000	..	16,000	83	700	10-11	Wl-ST	Wd-F	..	SC	B	Grs	E	$1,800	25	Yes	B. F. Mahoney—Ryan B1
350	4850	140	120	48	1250	..	..	150	1000	18	Wl-ST,D	D	Yes	DeDC	S	Arl	..	..	..	....	Metal—Flamingo
175	1175	90	75	35	700	.	....			....	Wl-ST	Wd-F	Yes	S Pl	..	RAR	E	...	..	....	Mono Aircraft—Monocoupe
500	1350	100	85	35	650	..	10,000	22	350	4.6	Wl-ST	Wd-F	No	S Pl	No	Grs	..	....	95	Yes	Mohawk—Pinto
300	2090	105	85	35	600	..	15,000	35	396	5	Wl-ST	Wd-F	No	S	No	RC	....	....	29	....	National Airways—Air King
..		85	.	30	925	..	..		360	....	Wl-ST	Wd-F	..	SC	Std	RAR	....	....	Apl	....	Nies—Williams
765	2082	100	90	35	500	25	12,500	38	400	9	Wl-ST	Wd-F	Ex	SPD	Ex.	RC	EH	$1,000	36	....	Pheasant—H-10
770	2512	136	115	45	1600	..	11,000	60	600	....	Wl-ST	Wd-F	Yes	S	Yes	Arl	....	$900	15	5%	Pitcairn—PA-5
160	3000	128	110	45		..		76		....	Wl-ST	Wd-F	Yes	S	....	Arl	....	...	..	....	Pitcairn—PA-6
785	1950	101	82	45		..		35	400	....	Wl-ST	Wd F		S	....	Grs	....	...	..	....	Pitcairn—PA-4
065	5065	114	96	59	750	..	12,000	110	540	17	D-cor	D-cor	Yes	DeDC	Yes	P	....	...	..	....	Prudden—S-E-1
900	2700	95	..	..				42		....	Wd-D	Wd-F		DeCP							Richmond Airways—Sea Hawk
000	15000	122	112	55	550	15	15,000	370	790	50	DOR, B	DOR, B	Yes	De D	Hy	RDO	....	....	Apl	5%	Sikorsky—S37
000	10000	125	110	55	850	15	19,400	2.0	500	36	Wd-D	DOR, B	Yes	DeD	....	DOS	WD	....	60	5%	Sikorsky—S38 Amphibian
600	1500	125	110	40	1000	17	16,000		250	5.5	Wl-ST	Wd F	Yes	S	....	....	....	....	..	5%	Simplex—Red Arrow
800	1837	104	95	30			15,000	40	400	....	Wl-ST	Wd F		SD		HyC	....	...	..	....	Sterling
565	2150	110	90	35	625		12,000	40	500	7	Wl-ST	Wd-F	Yes	PC	St.	RHy	D	....	Apl	5%	Stearman—C-2-K
962	2400	130	110	41	1000		18,000	55	620	11.5	Wl-ST	Wd-F	Yes	PC	St	RHy	D	$1,200	Apl	5%	Stearman—C-2-B
500	4500	125	105	56	900		11,000	90	750	11	Wl-ST	Wd-F	Yes	SPD	Std.	Hy	M	$2,500	74	....	Stinson—SM-1-D
900	2500	110	90	46	500		13,500	42	500	7	Wl-ST	Wd-F	Yes	DeD	Std.	By	....	....	45	5%	Stinson—Junior
850	2150	115	100	37	850		15,000	40	500	8	Wl-ST	Wd-F	Yes	DS	No	RC	....	....	73	Yes	Spartan—C-3
000	10000	114	100	55		12 5	14,000	235	510	30	D-cor.	D-cor.	Yes	DeD	St	O	....	....	..	....	Stout—Ford—4AT
730	2200	100		35	800			36	500		Wl-ST	Wd F			....	RC	....	....	21	....	Swallow—Commercial
550	1800	110	100	38	850			30	500	8	Wl-ST	Wd-F	Yes	SP	....	RAR	....	....	..	Yes	Taylor Bros.—Chummy
	2250									....	Wl-ST	Wd-F		S	....		....	....		....	Texas—Temple
200								120		....	D-cor	D-cor		De		Grs.					Thaden Metal—T-1
615	2248	114	95	40	800	20	15,000	43	440	10	Wl-ST	Wd-F	Yes	SpeD	Ex	R	EH Ex	$1,100	Apl	5%	Thunderbird W14-O
045	2496	135	110	42	1000	16	16,000	60	440	15	Wl-ST	Wd-F	Yes	SpeD	Ex	R	EH Ex	$2,950	Apl	5%	Thunderbird W-14-H
750	2100	100		42			12,000	42	410	8	Wl-ST	Wd-F	Yes	SPC	No	RC	....	....	30	....	Travel Air—2000
000	2600	130		45			20,000			12	Wl-ST	Wd-F	Yes	SPC	No	RC	....	....	32	....	Travel—4000
625	1100	126	107	50	700		13,500	78	650	12	Wl-ST	Wd-F	Yes	SPC	Yes	O	....	....	Apl	....	Travel Air—6000
960	2210	105		42				68	650	18	Wl-ST	Wd-F	Yes	SPC	....	RC	....	....	35	....	Travel Air—Siemens
850	1500	95	82	40	670	37	11,000	25	500	5.25	Wl-ST	Wd-F	Yes	SPD	....	Hy	....	....		....	Wallace—Touroplane
850	1000	97	90	35	600		14,000	40	350	5	Wd WIS	Wd-F	No	S		C	E	....	Apl	5%	Whites—Humming Bird
000	2000	95	85	30	500	20	12,000		500	5	Wl-ST	Wd-F	No	SC D	No	Grs	Own	$1,000	No	5%	Western—King Bird
000	2000	100	95	35	600		20,000	300	1000	20	Wl-ST	Wd-F	Yes	C	Yes	Arl	No	....	....	Yes	Zenith—Albatross

FUSELAGE AND WING CONSTRUCTION:
B—Bolted
Cor—Corrugated
D—Duralumin
F—Fabric cover
Mon—Monocoque
O—Open section
P—Plywood cover
R—Riveted
S—Steel
T—Tubing
Wd—Wood
Wl—Welded

BRAKES:
B—Bendix
Ex—Extra
H—Hydraulic
L—Lockheed
S—Sausedde
Std—Standard

LIGHTS:
N—Navigation lights

CONTROL:
A—Arens
C—Cables
D—Dual
De—Wheel
P—Push rods
S—Stick
Pl—Pedal

SHOCK ABSORBER:
Arl—Aerol
C—Cord
D—Compression
Grs—Gruss
Hy—Hydraulic
O—Oleo
P—Pneumatic
R—Rubber
RAR—Rusco Aero Rings
S—Coil Spring
T—Trombone

PONTOONS:
D—Duralumin
E—Edo
F—Fairchild
H—Hamilton
M—All metal
W—Wood

TYPE CERTIFICATE:
Apl—Applied for and is pending

GUARANTEE:
N—New

MANUFACTURERS' SPECIFICATIONS ON ENGINES AVAILABLE FOR COMMERCIAL USE AS COMPILED BY *AVIATION*

THE TABLE BELOW IS BELIEVED TO BE ACCURATE BUT *AVIATION* DOES NOT ASSUME RESPONSIBILITY FOR THE FIGURES GIVEN

This table will appear monthly and corrections and suggestions are invited

MANUFACTURER OR AGENT	Engine	Cooling System	Cylinder Arrangement	No. of Cylinders	No. of Cycles	Propeller Drive	Rated Hp. and R.P.M. at Sea Level	Maximum Hp. and R.P.M. at Sea Level	Weight Dry Without Hub or Starter	Weight Per Rated Hp.	Bore and Stroke (In.)	Compression Ratio	B.M.E.P.	Displacement (Cu. In.)	Frontal Area (Sq. Ft.)	Diameter of Mounting Ring or Distance Between Bearers (In.)	Height or Overall Diameter (In.)	Length Without Starter (In.)	Guaranteed Fuel Consumption at Rated Hp. Lb./Hp./Hr.	Oil Consumption Lb./Hp./Hr.	Valve Mechanism	Cylinder Construction (See Key)	No. Intake Valves Per Cylinder	No. Exhaust Valves Per Cylinder	Make Spark Plugs Supplied With Engine	Type of Ignition	Make Ignition	No. Carburetors	Make Carburetors	Make Starter	Are Exhaust Manifolds Provided	Shipping Weight Crated	Dept. of Commerce License	Cost at Factory
Aircraft Engine Co.	Comet	A	Rad	7	4	D	150-1800				4½x5½										prr	Al, S	1	1		2M	Se		Sy,E	Bs			N	
Allison Engineering Co.	V1410	A	1V-45°	12	4	D	410-1800	430-1900	1000	2.44	4⅝x7	5.3	128	1410		17	46¾	78½	.55	.03	ohc	Al, S	1	1	BG	2B	De		Sg²	Ea			Y	
Allison Engineering Co.	VG1410	A	1V-45°	12	4	G¹	410-1800	430-1900	1125	2.62	4⅝x7	5.3	128	1410		17		85⅛	.55	.03	ohc	Al, S	1	1	BG	2B	De	1	Sg¹	Ea			Y	
Allison Engineering Co.	V1650	W	1V-45°	12	4	D	420-1700	450-1800	825	2.10	5 x7	5.4	129	1650		17	46⁷⁄₁₆	74¼	.53	.025	ohc	Al. S	1	1	BG	2B	De	1	Sg	Ea			Y	
Axelson Machine Co.	Axelson A7R	A	Rad	7	4	D	150-1800		430	2.87	4½x5½	5.0		512			45½	35								M	Se	3	Sg			750	N	
Curtiss Aeroplane & Motor Co.	OX-5	W	V-90°	8	4	D	90-1400		375	4.17	4x5	4.9		502		12⅞			.55	.030	prr	Mo. C.	1	1		1M		1	Z		N		Y	
Curtiss Aeroplane & Motor Co.	OXX5	W	V-90°	8	4	D	110-1900		390	3.55	4¼x5	4.9		568		12⅞			.55	.030		Mo. C.	1	1		2M			Z		N		Y	
Curtiss Aeroplane & Motor Co.	C-6A	W	L	6	4	D	160-1700	165-1750	420	2.52	4½x6	5.2	133	573		15¾	39	57¹¹⁄₁₆	.52	.015	ohc	Al. Al. S.	2	2	AC	2M	Sp		Z	U	N	865	Y	
Curtiss Aeroplane & Motor Co.	D19	W	V-60°	12	4	D	435-2300	460-2500	880	1.47	4½x6	5.3	135	1145		15¾		56¾	.52	.015	ohc	Al, Al. S.	9	2	BG	2M	Sc	1	Sg	Ea	N	1080	Y	
Curtiss Aeroplane & Motor Co.	Conquerer	W	V-60°	12	4	D	600-2400	635-2450	760	1.26	5⅛x6¼	5.8	130	1569		15¾		56¾	.52	.015	ohc	Al. Al. S.	2	2	BG	1M	Sp	2	Z	Ea	N	1060	Y	
Curtiss Aeroplane & Motor Co. Inc.	Geared Conquerer	W	V-60°	12	4	G²	600-2400	625-2450	850	1.42	5⅛x6¼	5.8	128	1569		15¾		56⁵⁄₁₆	.52	.015	ohc	Al. Al. S.	2	2	BG	1M	Sp	2	Sg	Ea	N	1150	Y	
Curtiss Airplane & Motor Co.	Chieftain	A	H	12	4	D	600-2200	615-2200	900	1.50	5⅜x5⅛	5.4	130	1690		23⅜	45¼	51⅛	.60	.025	ohc	Al, S.	2	2	BG	DM	So	2	Sg	E	N	1325	Y	
Curtiss Airplane & Motor Co.	Challenger	A	Rad. S.	6	4	D	170-1800	180-1800	420	2.47	5⅛x4⅞	5.2	124	603		19	41¾	35⁵⁄₃₂	.55	.020	prr	Al. S	1	1	BG	2M	Se	1	Sg	E	N	850	Y	
Dayton Airplane Engine Co.	Bear	A	L	4	4	D	110-1550	125-1800	875	3.41	4½x7	5.8	118	444		16	39	47⅝	.505	.0175	ohc	Al. NI.	1	1		2M	Sp	1	Z	N	N	550		1600
Hallet Mfg. Co.	H-526	A	Rad	7	4	D	130-1800		425	3.26	4⅜x5	5.2		526		18½	48	37			prr	C.	1	1	BO	2M	BR	1	Z		N		N	1700
Irwin Aircraft Co.	Irwin 79	A	Rad	4	2	D	20-1700	25-2200	00	3.00	2⅛x2¾	5.0	110	79	2.0	4⅞	23	11	.45	.031	Au	Aa, Aa. S.	1	1	RB	1M	BR	2	Wf		N	100	N	625
Kinner Airplane & Motor Corp.	K-5	A	Rad	5	4	D	75-1725	112-1880	268	2.80	4.25x5.25	5.0		372		14	42				prr	Al, Al. S.	1	1	CH	2M	Se	1	Sg	H	Y	400	Y	1875
Kimball Aircraft Corp.	Beetle, Model K	A	Rad	7	4	D	135-1850		378	2.77	4¼x5¼	5.0	100	585		17	45	37½			prr	Al, NI	1	1		2M	So	1	Sg	Ee				
Menasco Motors Co.	B-2 Salmson	A	Rad	9	4	D	260-1500	278-1760	542	2.08	4.92x6.89	5.2					49⅛	38⅛	.42	.025	prr	Al. S	1	1		2M	O	1	Z					5,250
Michigan Screw Co.	Rover	A	L1	4	4	D	55-1800		210	3.81	3⅞x5	5.0		236							prr	NI	1	1		2M	Sc	1	Sg	N				
Packard Motor Car Co.	1A-2775	W	X-60°	24	4	D	1200-2600	1300-2700	1500	1.15	5⅜x6½	7	150	2775	5.22	14¼	45⅛	78⅛	.52	.03	ohc	S	2	2	BG	4B	Sc	4	Sg	O	V		Y	28,000
Packard Motor Car Co.	3A-1500	W	V-60°	12	4	D	600-2500	650-2700	760	1.26	5⅜x5½	5.5	140	1498	4.03	15¾	38¹¹⁄₁₆	62¹¹⁄₁₆	.52	.015	ohc	S	2	2	BG	2M	Sc	2	Sg	Ae	N	1275	Y	12,000
Packard Motor Car Co.	3A-1500	W	V-60°	12	4	D	600-2500	650-2700	880	1.46	5⅜x5½	5.5	140	1498	4.03	15¾	38⅜	65	.52	.025	ohc	S	2	2	BO	2B	De	2	Sg	Ae	N	1390	Y	17,875
Packard Motor Car Co.	3A-1500	W	V-60°	12	4	G	600-2500	650-2700	780	1.30	5⅜x5½	5.5	140	1498	4.03	15¾	38⅞	62¹¹⁄₁₆	.52	.025	ohc	S	2	2	BG	2M	Sc	2	Sg	Ae	N	1275	Y	12,000
Packard Motor Car Co.	3A-2500	W	V-60°	12	4	D	800-2000	835-2100	1160	1.45	6⅜x6½	5.7	135	2490	4.5	18¼	36⅛	69¾	.52	.015	ohc	S	2	2	BG	2M	Sc	2	Sg	Ae	N	2150	Y	15,625
Packard Motor Car Co.	3A-2500	W	V-60°	12	4	G	800-2000	835-2100	1380	1.72	6⅜x6½	5.7	135	2490	5.1	18¼	36⅛	76⅛	.52	.015	ohc	S	2	1	BG	2B	Da	2	Sg	Ae	N	2340	Y	19,375
Pratt & Whitney Aircraft Co.	Wasp	A	Rad	9	4	D	400-1900		670	1.67	5¾x5¾	5.2	124	1344		23⅛		43⅛	.55	.035	prr	Al. S.	1	1	BG	2M	Se	1	Sg		N	1150	Y	
Pratt & Whitney Aircraft Co.	Hornet	A	Rad	9	4	D	500-1900		760	1.52	6⅛x6¾	5.0	123.5	1690		23⅛		44⅛	.55	.035	prr	Al. S.	1	1	BG	2M	Se	1	Sg		N	1325	Y	
Pratt & Whitney Aircraft Co.	Geared Hornet	A	Rad	9	4	G²	500-1900		835		[illegible]	5.0	123.5	1691		23⅛		46⅛	.55	0.35	prr	Al. S.	1	1	BG	2M	Se	1	Sg		N		Y	
Quick Motors Co.	Quick-Radial	A	Rad	9	4	D	125-1450		325	2.8	4.13x5.51	5		667		19⅝	85	36			prr	Al. S.	1	1	CH	1M	Sc	1	Z					1750
Siemens & Halske A.G.*	Siemens Sh 13	A	Rad	5	4	D	80-1750		246	3.01	4.13x4.72	5.3		317		14	39⅝	34	.52	.022	prr	Al, S	1	1	O	2M	O	1	Sm	O	Y	693	Ex	[illegible]
Siemens & Halske A.G.*	Siemens Sh 14	A	Rad	7	4	D	115-1750		308	2.68	4.13x4.72	5.3		443		14	39⅝	32	.52	.022	prr	Al, S	1	1	G	2M	O	2	Sm	G	Y	726	Ex	2,650
Siemens & Halske A.G.*	Siemens Sh 12	A	Rad	9	4	D	125-1750		382	3.05	3.94x4.72	5.3		517		14.6	40½	32	.52	.022	prr	Al, S	1	1	O	2M	O	2	Sm	G	Y	800	Ex	2,970
Spartan Aircraft Co.	Walter 5	A	Rad	5	4	D	70-1600		225	3.21	4.13x4.72	4.4	112	317		11.35	37	27.5	.50	.028	oh	Al, S	1	1	AC	2M	Sc	1	So		Y	500	Y	1,835
Spartan Aircraft Co.	Walter 7	A	Rad	7	4	D	95-1600		280	2.95	4.13x4.72	4.4	108	444		12.6	37	28.5	.40	.026	oh	Al, S	1	1	AC	2M	Sc	1	Z		Y	580	Y	2,355
Spartan Aircraft Co.	Walter 9	A	Rad	9	4	D	135-1750		352	2.59	4.13x4.72	4.4	119	572		14.56	39	33.5	.49	.026	oh	Al, S	1	1	AC	2M	Sc	1	Du		Y	570	Y	2,940
Szekely, O. E., Corp.	SR-3	A	Rad	3	4	D	40-1800	45.6-1900	145	5.7	4¼x4¾	4.8	100	191	2.8	9⅛		23¾	.57	.030	prr	C	1	1		2M	BR	1	Z	N	N	205		765
Tips & Smith, Inc.†	Super-Rhone	A	Rad	9	4	D	125-1450	133-1650	315	2.52	4½x5½	5.2		667	4.75	11		39	.31	.036	prr	-, S, C	1	1	Sp	1M	Dx	1	Z			400	N	2,250
Velie Motors Corp.	Velie M5	A	Rad	5	4	D	45-1750		210	4.66	4⅛x3¾	5.2		250		12¾	32	97	.55	.025	prr	Al, S	1	1	AC	2M	Sc	1	Z	Ea	Y	420		1,050
Warner Aircraft Corp.	Scarab	A	Rad	7	4	D	110-1850	120-1925	270	2.45	4¼x4¼	5.2	112	422		17	35½	27¼	.50	.01	prr	Al, S	1	1	AC	2M	Sc	1	Sg		N			2,485
Wright Aeronautical Corp.	Whirlwind J5	A	Rad	9	4	D	200-1800	225-2000	500	2.50	4½x5½	5.2	123	788		19¼	45	33¾	.53	.035	prr	Al, S	1	1	AC	2M	Sc	1	Sg		N	1000	Y	4,980
Wright Aeronautical Corp.	Cyclone R1750	A	Rad	9	4	D	525-1900	560-2000	760	1.52	x6⅞	5.0	130	1753		23⅛	53⅝	40⅝	.55	.035	prr	Al, S	1	1	BG	2M	Sc	1	Sg		N	1530	Y	

*—Engines of foreign manufacture
†—rebuilt
a—applied for
A—Air cooled
Aa—Aluminum alloy
Ae—Aeromarine
Al—Aluminum
AS—Ansani or Scintilla
Au—Automatic
B—Battery ignition
BR—Robert Bosch
Se—Scintilla booster magneto

C—Cast iron
Ch—Champion
Cylinder Construction
first—head
second—walls or waterjacket
third—sleeve, if any
D—Direct
De—Delco
Du—Duplex
Dx—Dixie
DM—Dual Magneto
Ee—Eclipse

E—Ensign
Ex—Extra
G—Geared
G¹—5:3 epicyclic gear
G²—2:1 reduction gear
G.E.—General Electric
H—Hexagonal
I—Inverted
L—Cylinders in line
Mo—Monel
M—Magneto
NI—Nickle Iron

N—No
O—Owo
ohc—Overhead cam
prr—Push rods and rocker arms
Rad—Radial
Rad S—Staggered Radial
Sc—Scintilla
Sg—Stromberg
Sg¹—Stromberg NA-U5 duplex
Sg²—Stromberg NAS-8E

Sm—Sum
So—Solex
Sp—Splitdorf
S—Steel
U—U.S.L. Electric
V—Vee
W—Water cooled
Wf—Winfield
X—Extra
Y—Yes
Z—Zenith

what larger than destabilizing moment L_r due to yaw, the machine will gradually roll to the right and after one or two slight oscillations will resume the original attitude This is the case of normal stability If on the other hand, the Lv is smaller than moment L_r due to yaw, the latter will roll the machine to the left thus increasing the bank Increased bank will cause increase of the side slip, which

Fig 2

will in turn increase the rate of yaw and the destabilizing moment L_r Here we have the case of small initial side slip generating yaw, and yaw aggravating the side slip The machine deviates from the straight flight and travels along the spiral path, gradually tightening the turns This is the case of *spiral instability,* which is characterized in actual airplanes by tendency to overbank on the turns, and inability to make perfect turns by using ailerons alone, while holding the rudder practically neutral

Were the moment Lv due to dihedral very large, and the moment L_r due to yaw very small, the machine side-slipping to the left would level out too quickly. The forces due to angular as well as translational velocity of roll and of side slip would carry the machine past the normal attitude, and would make it bank to the right The bank to the right would cause the side slip to the right and the cycle would be repeated on right hand side Instead of the straight flight we have here the series of large oscillations alternating from one side to another This case is known under the name of *unstable oscillations* Actually the nature of flight varies from gentle persistant roll all the way up to severe oscillations increasing with each beat, depending on just how large is the dihedral and how small is the fin area. Slight further decrease of fin area or increase of the dihedral would lead to *spin instability* when the machine unstable in yaw tends to turn around and to fly tail first Thus we see that while the moment L_r—rolling moment due to yaw—is destabilizing, and the excess of it leads to spiral instability, a certain amount of it is quite necessary. It tempers the moment Lv—rolling moment due to side slip, the violence of which leads to unstable oscillations if not properly tempered. As the strength of the moment L_r for any given airplane depends on the strength of yawing moment Nv, we come to conclusion that there must be certain optimum value of the ratio of Nv to Lv at which the stability can be obtained

The rolling moment due to side slip which we designate by Lv depends on the amount of the fin area above the center of gravity, on sweepback of the wings and on the dihedral The dihedral, however, has so much more effect on the moment Lv than all the other factors combined that we can concentrate on it all our attention and disregard the rest Theoretical considerations[2] show that magnitude of the moment L_v can be determined by the formula

[1] $$Lv = K\, b\, \beta\, S\, n\, U$$

where

- b—is half span of the wing in ft
- β— the angle of dihedral, which we will measure in degrees
- U— the speed of flight
- S— wing area in sq ft
- n— slope of the lift coefficient curve which depends on the aspect ratio and can be determined with sufficient accuracy by the empirical formula.

$$n=\frac{0.1\, R}{R+2}$$

where R—aspect ratio determined as

$$R=(2b)^2/S$$

- K— numerical constant the value of which is of no interest to us now

The experiments confirm the formula [1] for the angles of attack within the flying range, but show that even straight wing has certain degree of stability in roll In order to account for this in the following work we will add ½ deg to the actual dihedral, using $\beta + 0.5$ instead of β in formula [1]

The yawing moment due to side slip, which is designated by Nv, depends mostly on the side area and shape of the fuselage and on the combined area of the vertical fin and rudder The yawing moment due to fin and rudder can be determined by the formula

[2] $$Nv = K\, s_t\, l\, n_t\, U$$

where s_t—is combined area of the fin and rudder

- l— distance from the center of gravity of the airplane to center of pressure on the vertical tail surface, which is located at 25 per cent of its mean chord Actually we will measure the distance l from the center of gravity to the rudder hinge The error thus introduced is very small, and the work of measuring and computing the data is made considerably easier
- n_t—slope of the lift coefficient curve for the vertical tail surface In view of a very small aspect ratio of vertical tail surfaces ordinarily used, the n_t varies but little, and we can assume for it the average value of 0.030
- U—speed of the flight

The yawing moment due to fuselage can be determined in a similar way by the formula

[3] $$Nv = 0.015\, K\, s_f\, X\, U$$

where

- s_f—side area of the fuselage in sq ft
- X—distance of center of pressure on the fuselage from the center of gravity X is positive if the center of pressure is behind the center of gravity, and negative if it is ahead of it The center of pressure is assumed to be at 25 per cent of the fuselage length
- 0.015—a constant taking place of n_t used for the fin

Now we can combine the formulæ 1, 2 and 3 and write the expression for the ratio of Nv and Lv as

[4] $$K=\frac{N_v}{L_v}=\frac{0.030\, s_t\, l + 0.015\, s_f\, X}{b\, S\, n\, (\beta + 0.5)}$$

The coefficient K we will call hereafter the *coefficient or lateral stability* The discussion given above makes us expect that certain values of this coefficient will correspond to stability, while certain higher values will correspond to spiral instability, and certain lower values will correspond to unstable oscillations In order to find out just what these values are, we will turn now to con-

sideration of the few actual cases characteristic for different kinds of stability and instability.

As the first example we will consider Aeromarine Mail plane AM-1 the photograph of which is shown on Fig 4 This machine was built in 1923 for replacement of DH-4 airplanes used at that time by the Air Mail The choice of it as an example for this article is justified by the fact that writer was placed in charge of its design, and is therefore thoroughly familiar with all its details, as well as with subsequent troubles It was realized that Air Mail pilots were accustomed to DH-4's, and the attempt was made to have the characteristics of the new machine somewhat similar to DH-4 Yet it was desired to improve the "directional stability," as the feature most important for the cross country flying To achieve this end the fuselage was made about three feet longer and the vertical tail surfaces were somewhat increased in size At the same time the upper wing containing almost 2/3 of the wing area was made straight, and only lower wing had the dihedral of 3", so that mean dihedral was only 1 15" instead of 3" for DH-4 The resulting difference between these two machines can be seen in Fig 3 Turning to the notation used in this paper we can say that moment N_r was increased while the moment L_r was decreased

The flight tests were disappointing The machine did not become "directionally stable," but on the contrary had to be kept on its path by the pilot Either one or another wing would become heavy After the spiral glide through the opening in the clouds the pilot found it difficult to level it The ailerons were heavy and ineffective, despite being balanced The rudder would swing the machine around, but there its effect ended the machine did not tend to bank in response to it To make a long story short the machine displayed what we know now to be spiral instability Check of the lateral stability coefficients now, five years after it was built shows the coefficient of 93 for this machine, as against 51 for DH-4 which had satisfactory stability characteristics

This example was related here in such detail as it is a very typical case of encountering the spiral instability because of a common misconception of the term "directional stability" The directional stability depends on the ratio of stability in yaw to stability in roll, and not on stability in yaw alone Were the present day knowledge available in 1923 the plane described above could have been very easily corrected by adding but 1 deg of dihedral, which would reduce the stability coefficient to 80

As the second example we will consider the flying boat "Malolo" designed by the writer and built by Edo Aircraft Corp in 1927 The boat was designed for the specific purpose of experimenting with lateral controls the object being to develop the machine which amateur pilots of little experience could use safely It was realized by that time that lateral stability depends on the coordination of the stability in roll and the stability in yaw, but the quantitative knowledge of their relation was lacking The machine was designed therefore as a braced monoplane, so that dihedral could be easily changed by using the bracing struts of different lengths The stability in yaw could be easily changed by changing the size of the fin and rudder

For the first flights it was rigged with a dihedral of 6 deg and with the vertical tail surface of 19.6 sq ft

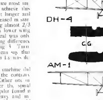


Fig. 3

It became immediately apparent however that such a rigging produced the instability classified as "unstable oscillations" It was necessary to control the boat all the time in order to fly in a straight line, and the controlling had to be done by the rudder The use of ailerons did not help to keep it on a straight course and the less they were used the better it was When all the controls were held in a neutral position at about cruising speed the generation and mechanics of the oscillations became quite evident The boat was observed to deviate from the straight course, banking more rapidly than turning, until it overbanked and sideslipped Then it leveled out rather briskly and banked to another side repeating the cycle The flight consisted of a series of turns alternatively to the right and to the left apparently quite steady and persistent without any tendency either to increase or die out The banks reached about 30 deg Average direction of the flight was maintained quite well, and while making these turns the machine felt steadier and more secure than in normal flight with its odd tendency to hunting

Fig 4 Front view of the Aeromarine mail plane AM-1

For the next experiment the dihedral was reduced to 3 deg, the boat not being changed in any other way It was found that it behaved much better, but not quite well yet It is probable that were it tested first in this condition, its handling would be classified as "peculiar," "so-so" or some similar vague expression The test pilot, however, being familiar with all the symptoms from the first tests, detected them easily in this case, and was able to reproduce the oscillations These, however, were much more gentle, the bank on each turn not increasing beyond 20 deg It was evident that instability was much less pronounced, but still remained of the same type—"unstable oscillations"

For a third experiment the vertical fin and rudder were changed, increasing the vertical tail area from 19.6 to 27.8 sq ft Dihedral remained the same and the boat was not changed in any other way The boat was found to be very good on lateral controls and was flown for several hours in this condition During one of these flights with rather heavy load the boat was accidentally stalled during the climb and began to settle or sink Quite rapidly it sank through some 150 ft of altitude, hit the water on almost even keel and rebounded, all this without the least tendency to swerve or fall on the wing It was really the lack of these familiar signs that allowed an experienced pilot to stall the machine The use of ailerons and of the rudder was tried on very flat glides and they were found to be quite effective at low speed This is particularly interesting because while the boat had "unstable" rigging, several pilots complained of very weak controls It proves that it is unadvisable to pass judgment on controls, until the lateral stability is properly adjusted

Returning to the "coefficient of lateral stability," we find that in its best, most stable condition, the boat had a coefficient of 44, in the second experiment, displaying moderate instability, the coefficient was 26, and in the most unstable condition it was 15 Thus we see that a low value of the coefficient indicates the presence of the type of instability known as unstable oscillations and the high value—found in Mailplane AM-I—indicates the spiral instability In Table I we collected the data on a number of airplanes for which we computed the coefficient of lateral stability The airplanes are divided in three groups—first one containing the machines definitely known to display spiral instability, the second one containing two cases of "Malolo" displaying unstable oscillations and third is the largest group of 38 airplanes which are supposed to be satisfactory Some machines in this group, such as Aeromarine E0 and De Haviland 4 are definitely known to the writer to be satisfactory others are assumed to be satisfactory in absence of information to the contrary As these machines were chosen at random from the airplanes in use, one can expect the average value of the coefficient to be fair approximation to the best value The choice of the airplanes listed in the Table 1 was limited to airplanes of American or English manufacture as the conception of the stability and the tendency of designers in these two countries are very similar The French airplanes as a rule have very little dihedral, and we are inclined to consider many of them as spirally unstable German designs show no definite tendency and their airplanes vary from complete lack of dihedral to very large dihedral It is useless to consider the problem of airplane stability as something abstract The opinions of the pilots on what is required in the way of stability depend on their training and their past experience We are concerned in this article with the definite problem of giving the rule for proportioning of the airplanes to satisfy the tastes of American and English pilots In our study therefore we use the statistics of the American and British airplanes

TABLE 1

Coefficient of lateral stability for several airplanes

Remarks	*Make and Model of Airplane*	*Coefficient*
	Spiral Unstability	
(a)	Aeromarine E0—Exper Large Fin	109
(a)	Aeromarine Mail Plane AM-1	93
	Curtiss JN-4	108
	Unstable Oscillations	
(e) (c) (a)	Edo Malolo—Experimental 1	15
(e) (c) (a)	Edo Malolo—Experimental 2	26
	Supposedly Normal	
(a)	Aeromarine E0—as built	72
(a)	Aeromarine E0—Exper. large fin and diheiral	25
(a)	Aeromarine AMC	85
(a)	Aeromarine—40	36
	Avro 504	52
	Blackburn—"Sprat"	27
	Boeing—Mail Plane	93
	Bristol—"Badmington"	88
	Bristol—Fighter	43
	Boulton & Paul "Bugle"	43
	Consolidated PT-1	89
	Curtiss "Fledgeling	87
(a)	Curtiss NC-1	95
(a)	Curtiss HS-2L	37
	De Haviland 4	51
	De Haviland "Moth"	63
	De Haviland "Conberra" 61	32
	De Haviland 66	76
(a) (c) (e)	Edo Malolo—Experimental 3	44
(b)	Fairey III	87
	Gloster "Grouse 11"	38
	Gloster "Grebe 11"	53
	International F-17	57
(c)	Lockhead "Vega"	91
(c)	Lone Eagle	38
	Marine Bomber NBS-1	79
(d)	Mercury 6W-3	91
	Pitcairn "Fleetwing"	78
	Pitcairn "Mailwing" PA-5	53
	Pitcairn "Orowing"	70
(e)	Ryan "Brougham	67
	SE 5a	44
(a)	Short "Calcutta"	41
	Sopwith "Camel"	56
(e)	Stinson—SM-1	86
(a)	Supermarine "Southhampton"	80
	Swallow 1927	89
(e)	Travel Air—5000	28
	Average for supposedly normal airplane	62

Remarks

(a) Flying Boat.
(b) Float seaplane.
(c) Cantilever Monoplane—½ deg added to designed dihedral to allow for deflection of wings
(d) One degree of dihedral is allowed for every 6 deg of sweepback
(e) Wing bracing struts are considered as lower wings at large dihedral Only ½ of the area of struts is taken into account

We find that average value of the coefficient of lateral stability for the machines in use in this country or in England is 62 If we adjust the dihedral and vertical fin area in design of a new airplane to give the coefficient of 62 we can be reasonably certain that it will have the normal characteristics in respect to aileron and rudder controls. Certain amount of deviation is permissible, of course, and probably the range from 40 to 80 is perfectly

safe It is the writer's belief, that it is not safe, however, to go to the limit of variation shown by the airplanes listed in the table as supposedly normal To start with, it is only recently that we began to understand correctly the meaning of lateral stability. The lack of definite standard of comparison and the dependence on personal opinion of different pilots is responsible for wider variation of characteristics of different airplanes than it is necessary.

On the other hand we should not forget that in this method we took into account only two most important characteristics, and neglected seven less important ones. The variation in these neglected characteristics may widen or narrow down the range of permissible values in the coefficient of lateral stability Thus Aeromarine AMC was satisfactory with coefficient as high as 85 while Aeromarine AM-1 showed marked spiral instability at only slightly higher value of 93 Aeromarine E0 is satisfactory at 25, while the "Malo" displayed "unstable oscillations" at 26. We repeat that we can be reasonably certain only of narrow range near the best value of 62, but that we cannot deviate far from it, without risk of instability.

We want to call the reader's attention to the fact that value of coefficient of lateral stability indicates the *kind* of stability or instability and not the *degree* of it If the coefficient is low, the airplane tends to oscillate badly about the straight line of flight repeatedly crossing it, and it can be controlled best by the rudder. If the coefficient is high, the airplane tends to deviate from straight path for good and to assume spiral flight It can be controlled best by ailerons. Even if the coefficients do not deviate far enough from the normal value to cause actual instability, they indicate the nature of controls on turns, favoring the use of rudder in one case and ailerons in another.

If the coefficient has normal value of 62, the airplane is stable in the sense that it has no tendency to deviate from the straight course on its own accord, and that use of ailerons and rudder is well balanced Whether the airplane will return to normal flight after some disturbance or not depends on the actual amount of dihedral or fin surface, which control the degree of stability

The airplane with no dihedral and exceedingly small fin area may be proportioned to have the coefficient of 62 It will have then no tendency to deviate from the normal flight, and in calm weather it can be flown with hands off On turns it has no tendency to overbank, neither has it any preference to correct bank If it is disturbed by a gust of wind, or by a jerk of controls it will side slip or skid indefinitely without any tendency to right itself We say that this airplane is neutral in regard to stability

The normal airplane must have fair amount of the fin surface, and the dihedral proportioned so as to give the normal value of the coefficient of 62. Then not only it will not deviate from straight flight on its own accord, but will return to it after each disturbance On turns it will have definite preference to correct bank, and will assume it naturally, even if rudder and aileron movements are not properly coordinated by the pilot It can be controlled by either ailerons or rudder, or by any combination of both Not requiring very fine coordination of these two controls, it will be easy to fly

So, the ratio of stability in yaw to stability in roll which we termed the coefficient of lateral stability, must have certain fixed value if instability is to be avoided We suggest the fixed value of 60 The degree of stability is determined by actual amount of stability in yaw or of stability in roll The designer can have here very wide choice of their amount As long as the machine is stable and ailerons and rudder have thereby their natural effects, the degree of stability is of secondary importance There is one condition, however, which leads us to choice of rather high degree of stability. This is the condition of controllability at the angles above stalling and freedom from incipient spin

When the airplane is stalled and reaches the angle at which autorotation is possible, the drop of one wing is accompanied by large increase of drag of this wing This drag is further increased by lowering the aileron, when the pilot attempts to check the roll Greatly increased drag of the dropping wing yaws the airplane to the same side, and the yaw generates additional rolling moment accelerating the autorotation These events follow one another in rapid succession and the deadly incipient spin develops Theory and practice agree in that incipient spin can be prevented, and the plot can retain the control of the machine, if the rudder is powerful enough to overcome the yawing tendency of the wing. It has been shown[4] that this condition is fulfilled, if

$$[5] \qquad \frac{s\ l}{S\ b} \geqq 0.05$$

where s—area of the fin and rudder in sq. ft
S—area of wings
b—half span
l—distance from center of gravity to the center of pressure on fin and rudder, or approximately to the rudder hinge

This expression calls for somewhat larger fin and rudder area than is found on most of the present day airplanes

We suggest to the designer, therefore, to choose the area of his vertical tail surface from the consideration of controllability at low speed and at the angles above stalling, using formula [5] Once the area of the vertical tail surface is decided upon, the amount of dihedral needed for stability can be easily determined from the formula [4] Let us assume for example that we are laying out the design of an airplane and have decided already on the wing area of 300 sq ft, on the span of 32 ft and on the length of tail from center of gravity to the rudder hinge of 15 ft. Let us assume, moreover, that side area of the fuselage is equal to 60 sq ft, and that nose of the fuselage projects 7 ft. ahead of C G, making total length of fuselage, including propeller spinner, 22 ft The center of pressure on the side of fuselage we will assume to be at 25 per cent of its length, i e 5 5 ft from the bow or 1 5 ft ahead of center of gravity From the expression [5] we have

$$\frac{s \times 15}{300 \times 16} = 0.05$$

hence

$$\mathbf{S} = \frac{0.05 \times 300 \times 16}{15} = \mathbf{16\ sq.\ ft.}$$

Aspect ratio $R = 32^2/300 = 3.41$

$$n = \frac{0.1\ R}{R + Z} = 0.063$$

from expression [4], substituting $\beta + 0.5$ instead of β and $K = 60$ as explained above, we have

$$60 = \frac{0.030 \times 16 \times 15 - 0.015 \times 60 \times 1.5}{0.063 \times 300 \times 16 \times (\beta + 0.5)} \times 10{,}000$$

or

$$18144\beta = 72000 - 13500 - 9070 \times 49430$$

$$\beta = \mathbf{2.7\ deg.}$$

Thus we find that our airplane should have the mean dihedral of 2.7 deg and the vertical tail area of 16 sq ft

(1) *"Stability and Controllability of Airplanes"—Aviation, April 27 1925*
(2) *A C A Rep. and Memo No 1077*
(3) *E P Warner "Aerodynamics" page 410*
(4) *"The Control of Stalled Airplanes"—The Journal of Royal Aeronautical Society June 1926.*

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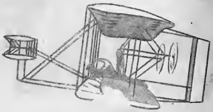

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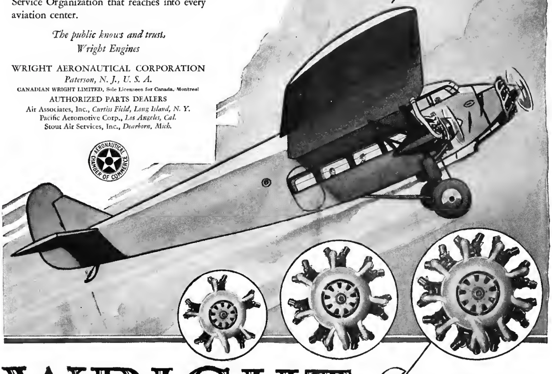

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